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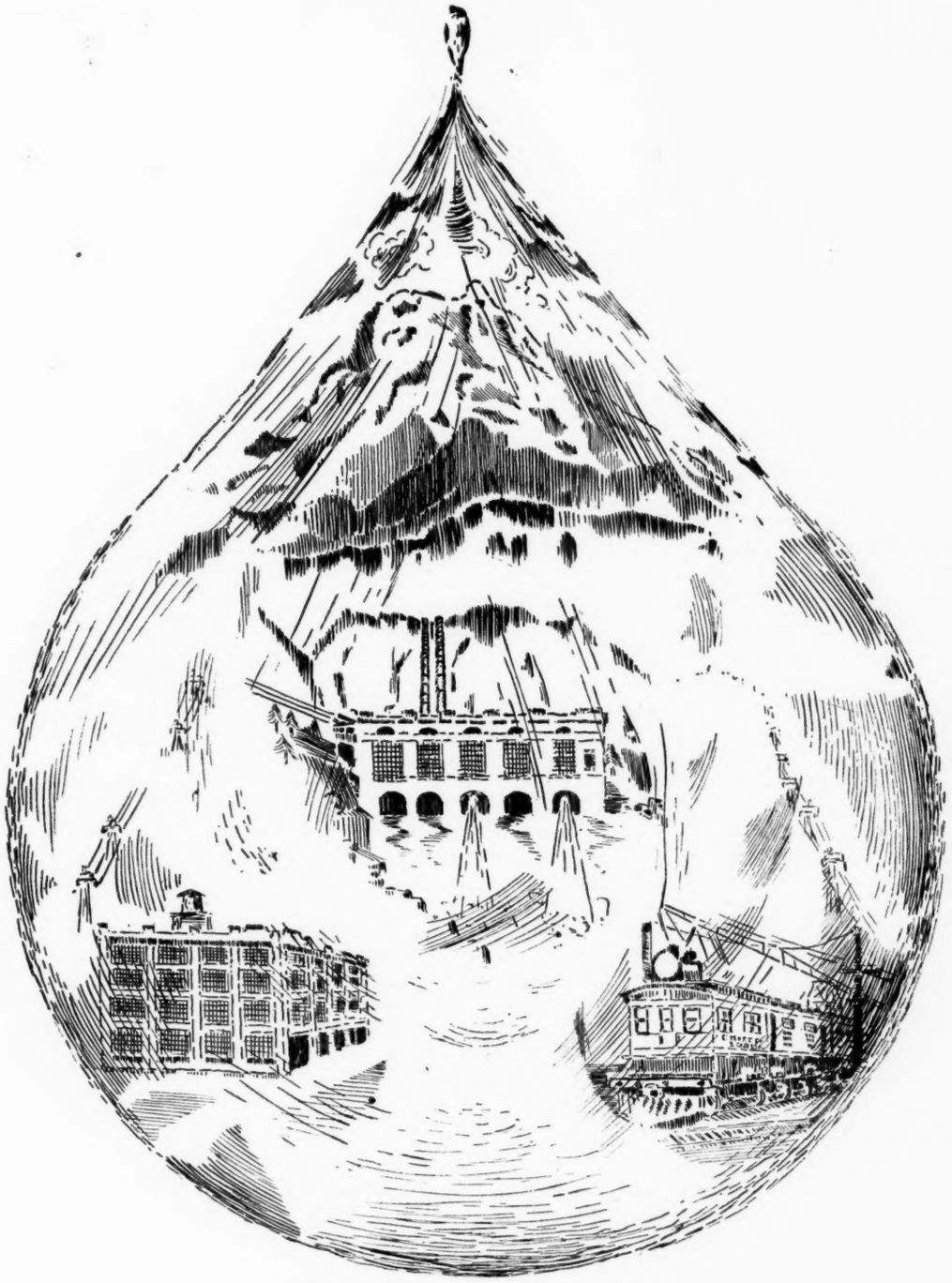


"LITTLE DROPS OF WATER"

Ten Million Hydro-Electric Horsepower to begin Development in 1921

Contributed by C. H. Bromley

New Ford Plant Power House at River Rouge

Immense Double-Ended Boilers 83 Feet High, Having 26,470 Square Feet of Steam-Making Surface, Are Arranged To Burn Blast-Furnace Gas and Powdered Coal

CONSTRUCTION is progressing at River Rouge, Michigan, on the new Ford Plant, which is to be the first complete consolidated blast furnace, steel mill, foundry and manufacturing plant in the world. When it enters into full production, it is aimed to make every casting and steel part used in the Ford cars, trucks and Fordson tractors at this plant. One of the unique features previously considered impracticable is the plan to pour the hot metal from furnaces directly into molds in the foundry in conjunction with a certain proportion of metal from the cupolas, eliminating to a large extent the remelting of the pig iron in the foundry. The site of this plant on the River Rouge, three miles up from the Detroit River, covers nearly 1,500 acres. It is at present occupied by immense storage yards for coal, stone and ore; 120 coke ovens producing 1,700 tons of coke, 15,000,000 ft. of surplus gas, some of which is supplied to the City of Detroit, 4,000 gal. of benzol, 16,000 gal. of tar, and 27 tons of ammonium sulphate for fertilizing purposes, during each 24 hours. There are also 4 blast furnaces, each producing 500 tons of iron daily; a foundry built adjacent to the blast furnace; a large body plant, converted from the Eagle Boat job; a waterway with a turning basin large enough for the largest lake vessel, with a slip one-half mile long, 250 ft. wide and 25 ft. deep; and what will be of particular interest to *Power* readers, a large power plant consisting of enormous boilers burning blast-furnace gas and pulverized coal. At present only meager details of the plant are available, principally because important units of the power plant are not yet in operation, and also because of the complete shutdown of the Ford properties; but upon resumption of operation complete information is promised for publication in *Power*. The present article will give some idea as to the magnitude of the undertaking, and show the general layout.

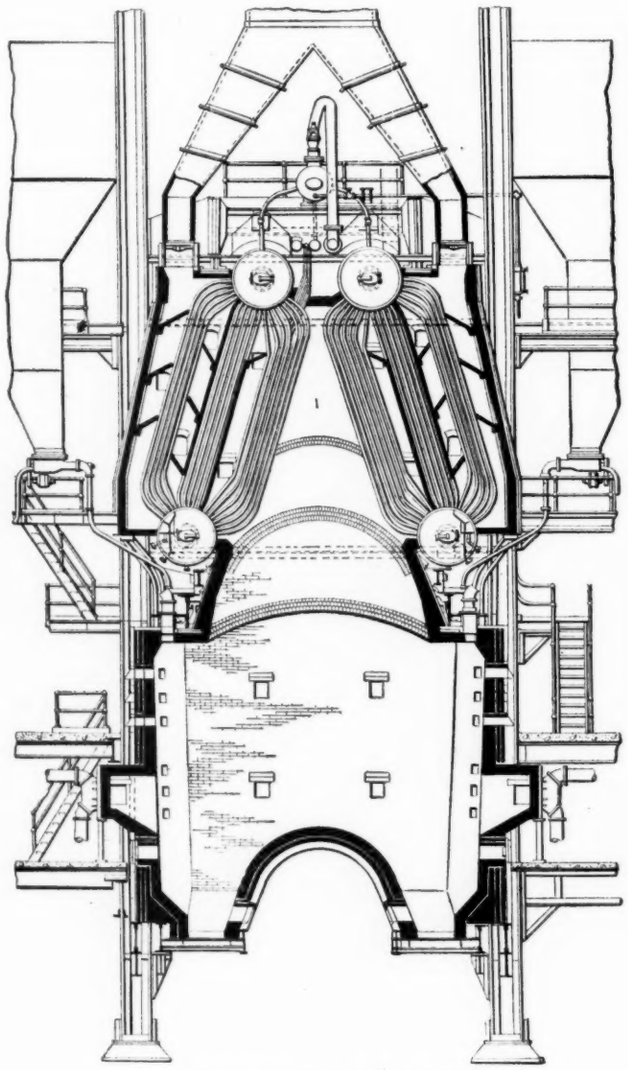


FIG. 1. SECTIONAL VIEW OF BOILER

As shown by the plan view of the power house, the complete measurements are 326 ft. by 220 ft. with provisions made for 50 per cent increase in area. The entire structure is supported on piling and a concrete mat. The buiding is of concrete, steel and brick, to harmonize with the architecture of surrounding structures. Reference to Fig. 2 will show the switchhouse at the extreme right, with a frontage of 176 ft. and a depth of 47 ft. The next is the turbo-generator room, which extends above and beyond the switchhouse, the length being 220 ft. and the width 69 ft. The original layout calls for 65,000 kw. capacity in four turbo-generator units designed to generate 4,600 volt three-phase 60-cycle current. The first two units of 12,500 kw. capacity each have been installed by the General Electric Company and one is in operation.

On the west or left side of the building, at grade-level, is the turbo-blower room, which is laid out for five turbo-blowers, each to have a capacity of delivering 40,000 cu.ft. of air against a pressure of 23 lb. per sq.in. Three of the blowers are at present installed and in operation. Between the turbo-blower room and the turbo-generator room, and separated from either by an open court 22 ft. wide, is the boiler house, which has an over-all width of 117 ft. and towers above the other structures to a height of 120 ft. from the ground floor. A steel stack for each boiler, 11 ft. in diameter, rises above the roof nearly 200 ft. and 327 ft. above the ground-floor level. They are supported on the upper steel structure of the boiler room, the regular building columns taking the weight. The final plans call for eight Ladd boilers in the present building, but four make up the initial installation.

These boilers are the largest single units that have been built in this country, containing 26,470 sq.ft. of steam-making surface; steam is to be generated at 225

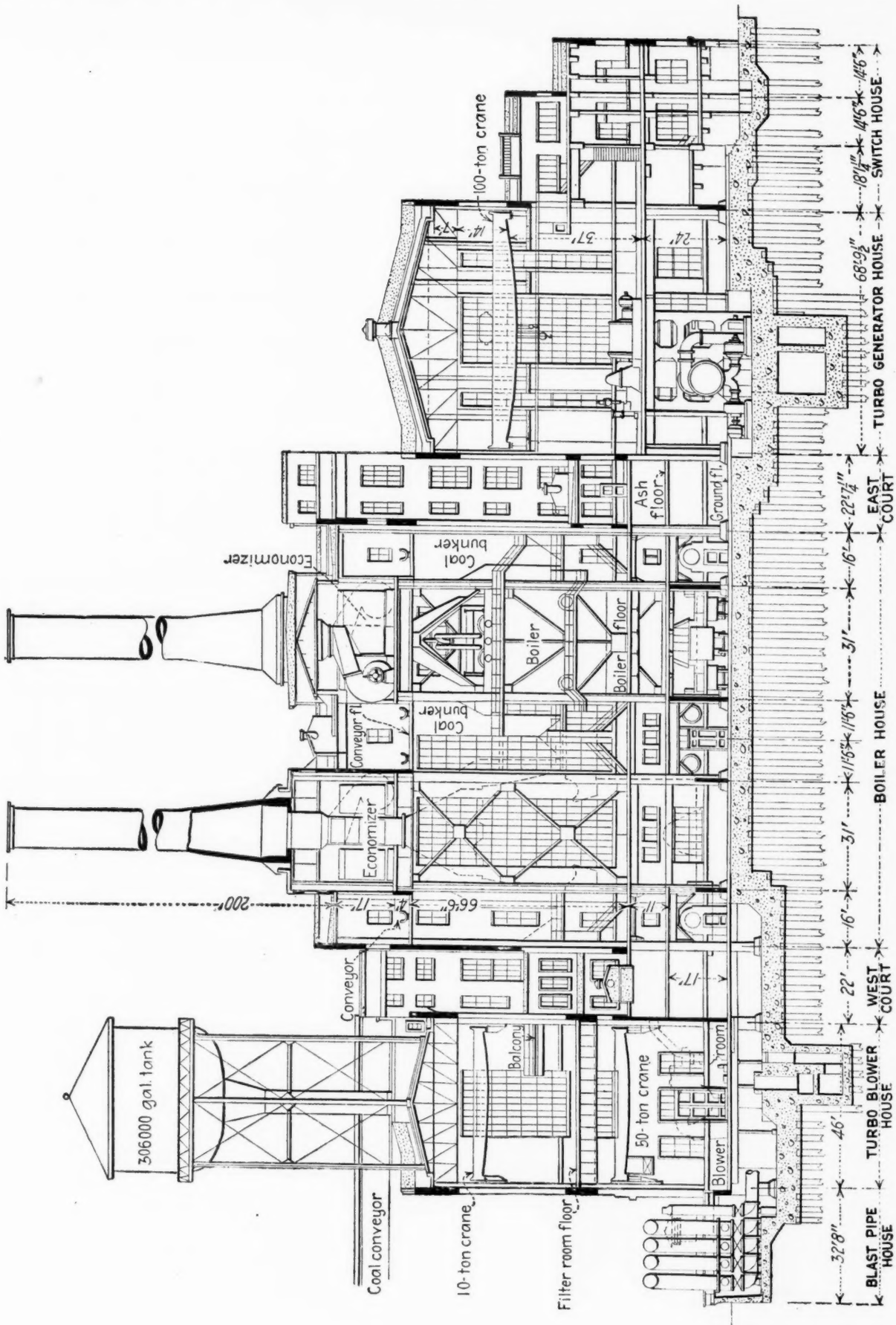


FIG. 2. SECTIONAL VIEW OF RIVER ROUGE PLANT

lb. pressure and 200 deg. superheat. Boilers are of the double-ended type with an element on either side consisting of an upper and a lower drum connected by three banks of tubes averaging 20 ft. 6 in. in length. Tubes between drums number 1,467 and, if placed end to end would extend a distance of six miles. Above and midway between the two elements is a 36-in. steam drum, common to both. Steam from the top drums of the two elements is fed to this steam drum, and through two 10-in. nozzles is conducted to the two inlet headers of the superheater located below the steam drum and at the center of the boiler.

From both sides of the setting the breeching unites into a common smoke flue leading to the stack above. Economizers are not to be installed at present, but provisions have been made for them; their location with induced-draft motor-driven fans is to be above the boilers, as indicated in Fig. 2.

Between column centers the boiler-plan measurements are 29 x 31 ft. The floor space required per unit is thus practically 0.034 sq.ft. per sq.ft. of heating surface. From the enormous furnace provided for burning the powdered coal and blast-furnace gas to the top of boilers the height is unusual, the measurement from the ash floor to the top of the superheating piping being nearly 83 ft. Above this is a conveyor floor and a space provided for future economizers. Reference to Fig. 3 will give some indication of its furnace design and its great volume. Each of these boilers is provided with four blast-furnace gas burners and four pulverized-coal burners, which will be described later.

With pulverized coal to be used to meet steam requirements above that supplied by the gas, normal operation at 250 or 300 per cent of boiler rating and peak loads up to 400 per cent are expected. For this reason pure feed water was considered highly desirable, and accordingly a Griscom-Russell evaporative system of feed-water purification, having a capacity to supply 25 per cent of the total feed water, has been provided. This system, which is made up of nine first-effect and nine second-effect evaporators and purifiers, is of unusual interest and will be given a full detail account as soon as it is ready for operation. The equipment is located on the floor above the turbo-blowers, and here also are the air compressors previously mentioned, and two immense Hoppes open heaters supplying feed water at a suitable temperature to the boilers by two turbine-driven multi-stage centrifugal pumps under governor control, with individual feed-water regulators on each boiler.

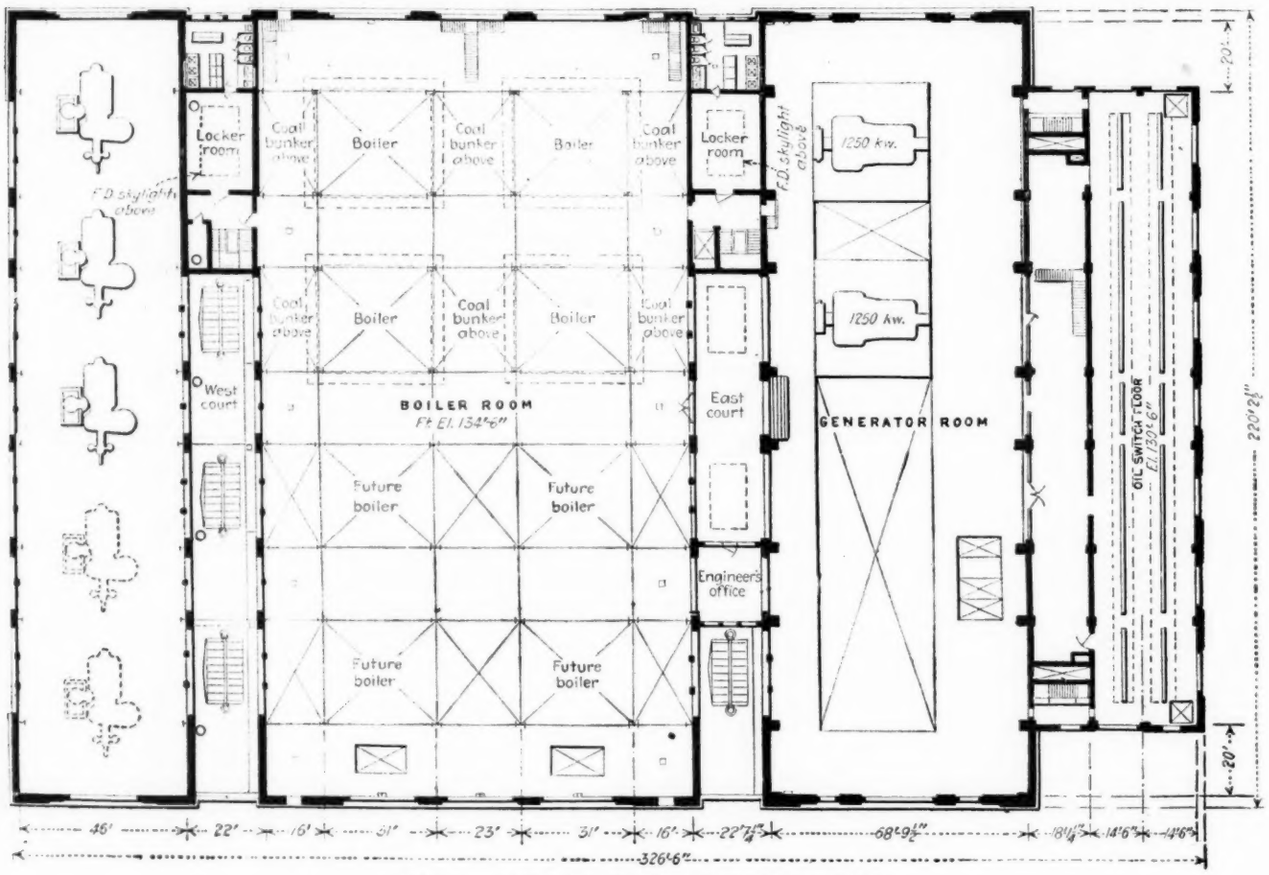


FIG. 3. FLOOR PLAN, RIVER ROUGE PLANT

A large pulverizing plant consisting of twelve air separation mills, conveyors and fuel equipment is under erection. This plant, as well as the pulverized-coal burning equipment, is being supplied by the Combustion Engineering Corporation, of New York City. Duplicate screw conveyors are to carry the prepared fuel to the overhead bunkers in the boiler house. It will be evident that there is a bunker over the central aisle of the boiler room, and one over each outside aisle for the convenience of each lower burner. Only half of the pulverizers are being installed at the present time. Coal from the Ford mines in West Virginia and Ken-

tucky will be the fuel used. For full operation it has been estimated that over 1,000 tons of this coal will be consumed per day. From the mines to the ashpit none of it will be handled manually. From the railroad cars to the car dumper, then to the pulverizer house, across to the boiler-room bunkers, down through the furnaces and the final removal of the ashes into small dump cars—all operations are mechanical.

At an early date the main features of the plant will be described in detail, and operating data which will be of considerable interest will be published as soon as available.

Home-Made Oil Pump

By O. B. Critchlow

The accompanying sketch is of a pump, such as I once made for an oiling system. It is constructed from pipe and fittings, with the exception of the plunger *A*, which is made from 1-in. round iron stock, drawfiled and smoothed up with emery cloth. The only features that may need explanation are the stuffing box and gland and the method of closing up the bottom of the pump. The threads in the center of the coupling *B* forming the stuffing box were removed by machining on a lathe; the gland *C* was made by cutting an extra-long thread on a piece of pipe, afterward running the die on reversed to remove the taper and then cutting the pipe off sufficiently high above the thread to leave a grip for a pipe wrench to tighten down. The bottom of the pump was fitted with a flange *E* and closed by pouring the nipple *D* full of lead.

The pump was placed in a baking pan to catch leakage, and the whole was fastened to the floor with large wood screws; a pin inserted in the hub of the low-pressure valve rocker supplied the power. This pump gave as good service as any pump could for several years, until the plant growth put it in the scrap.

A strainer is required on the suction to keep out small particles of waste and dirt, otherwise this material will get under the check valve and cause trouble.

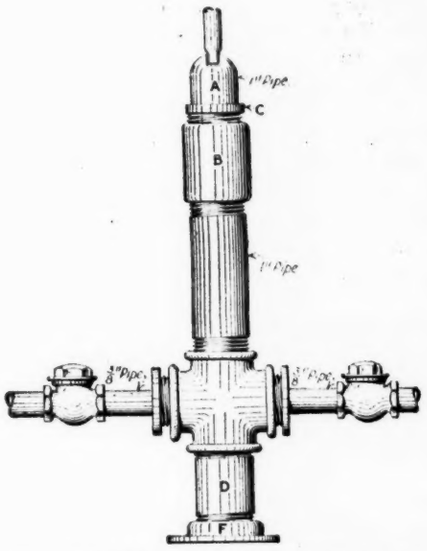
Some particulars of the engine itself may be of interest, since they also have a bearing on the question of lubrication. At the time this engine came under my care it had been in service a little more than two years, during all of which time it had had a most vicious and nerve-racking pound. This pound was intermittent in character, coming and going at irregular intervals and without being affected by variations of load or steam pressure. When at its worst it could easily be heard two blocks distant and had so frightened the erector on its initial performance that he ran from the building, so the owners told me. The engine had been dismantled a number of times in a vain search for the cause of the noise. The owners had finally come to accept it as a part of the contract and were plainly skeptical when I expressed the belief that I should be able to locate it.

Noting the engine's performance for some time I became convinced that faulty lubrication of the low-pressure cylinder was to blame for the infernal racket. The engine was provided with a single-feed lubricator of the hydrostatic type, connected in the usual manner, no provision being made for feeding oil directly to the low-pressure cylinder. The valve of this cylinder was of the rotary type, located in a cylindrical chest beneath the cylinder, and it seemed to me that this formed an excellent oil trap, as the steam coming from the high-pressure cylinder, reduced in temperature and velocity and checked by the closing and opening of the low-pressure valve, would readily precipitate the oil it contained.

With this idea in mind I removed the cover of the valve chest, pulled out the valve and found the steam space well filled with a lovely pool of cylinder oil. It was evident that the only time this cylinder received oil was when this pool became sufficiently high for the inrushing steam to carry a gulp in; when this occurred the noise would cease for a time.

The purchase and installation of a double-feed oil pump with one connection run to the top of the low-pressure cylinder at midstroke drove this annoyance away for good.

The exhaust of this engine was connected to an independent steam-driven jet condenser that also had given



OIL PUMP MADE FROM PIPE AND FITTINGS

much trouble. It would lose its vacuum on the slightest provocation, and once lost it could not be restored to service until the engine was shut down. No stop valve had been installed between the engine and the condenser, but the condenser had a 2-in. priming line which should have made it possible to start at any time. An examination revealed that the cylinder head of the circulating pump had never been removed since it came from the builders. When this was done it was found that the piston had never been packed; also further search disclosed that the suction, which came from a well beneath the floor, was not provided with a foot-valve. When these defects were remedied there was no more failure.

According to *Engineering*, of London, an order has been placed by the Lonely Mine Co. of Rhodesia, for a large gas-power installation comprising four Crossley waste-wood suction gas plants with a total output of 1,400 b.hp. The fuel will be wood logs of up to 2 ft. long and 12 in. diameter, and the gas obtained will be utilized to drive four horizontal gas engines. Three of these engines will be of the four-cylinder type, each with a working load of 350 b.hp. at 200 r.p.m., and direct-coupled to an alternating-current generator. The fourth will be a three-cylinder engine with a normal working load of 275 b.hp. at 200 r.p.m., direct-coupled to a tandem air compressor.

The Diesel-Engine Industry

By L. H. MORRISON

TO THOSE not intimately acquainted with the Diesel-engine industry in the United States the statement that the total output of the several manufacturers since the first introduction into this country amounts to more than 370,000 horsepower will be somewhat surprising. Particularly interesting is the development since the expiration of the original patents. The wonderful impetus given the industry by the engagement of a number of manufacturers in the building of Diesel engines serves to prove the statement that competition is always stimulating.

The increase in total horsepower sold per year, comparing the early years with 1919 or 1920, is quite comparable with the increase in the capacities of the individual units. In Fig. 1 is shown the first engine constructed in the United States in 1898, being of 60 hp., compared with a modern Diesel. Likewise the yearly output has increased from 60 hp. in 1898 to 68,000 in 1919, as will be noted from a study of the chart in Fig. 2. In the preparation of this chart all the Diesel manufacturers have been consulted. Since many of the older units have been re-erected in other than the original plants, it was necessary to trace a considerable number of the older engines. For this reason a few minor errors exist in the totals for the first ten years; these errors will not amount to over 2,000 hp. for the entire range of the chart. A few of the early engines have been discarded or are used only as breakdown service; consequently, they may appear in Fig. 2 but not in the subsequent diagrams.

One of the interesting facts to be gained from this chart is the continued service obtained from practically all the engines constructed. Many engineers hold decided views against the oil engine, basing their prejudice on the statement that the Diesel, especially of the early design, has been a failure. To the contrary, no other prime mover can show such a record of continuity of service. If, out of a total of 370,000 hp., less than 6,000 hp. are no longer in service, the impartial investigator must decide that its life is fully equal to that of a steam unit. It is well to add here that of the total horsepower of discarded engines some 2,000 hp. were installed in a plant that was destroyed by fire from causes other than arising primarily from the engines. The application of Diesel power is not confined to narrow limits, the engine being employed in a large variety of industries. In Fig. 3 are shown the total Diesel installations separated into the classifications of the industries served and the percentage of the total number of Diesels so employed. As might be expected from its very apparent adaptability to such work, the greatest volume of Diesel horsepower is employed in the central stations and in the oil pipe-lines. Since the business of the oil pipe-lines is to transport petroleum, the oil engine is especially suited for such pumping stations. As new oil fields are opened up the demand for this engine increases. With the developments in Canadian and South American fields a large number of American Diesels will be used since the American manufacturer has solved the problems of oil-line drive more successfully than have the foreign builders.

The Diesel has found a general acceptance in central stations of capacities under 2,000 kw. In these small- and medium-powered plants it is impossible to install an efficient steam plant with all the necessary auxiliaries. As a result the Diesel has been largely sold in such plants. That the service has proved satisfactory is attested by many repeat orders. The operating cost per kilowatt is well under usual steam-plant records and compares quite favorably with the cost of the largest central stations. The overhead charges in view of the present costs of steam-plant equipment are not excessive, as has been outlined in a number of Diesel central-station plant-cost records published in *Power*. Since the Diesel is a self-contained unit, corporations controlling a number of central stations have found that it can be installed in one locality when the power demand is not high, and afterward, when the load conditions justify a turbine plant, the Diesel can be moved to another station with practically no depreciation.

The increased use of the Diesel in several industries is shown in Figs. 4 and 5. Of these industries it appears that while other lines have purchased a greater yearly horsepower of Diesels, the growth of the Diesel central stations has been the most consistent. The more general adoption of the Diesel to refrigeration plants is to be expected. The increased use of raw-water plants makes the oil engine the most economical prime mover when fuel-oil prices are reasonable, the fuel costs being as low as 15 cents per ton

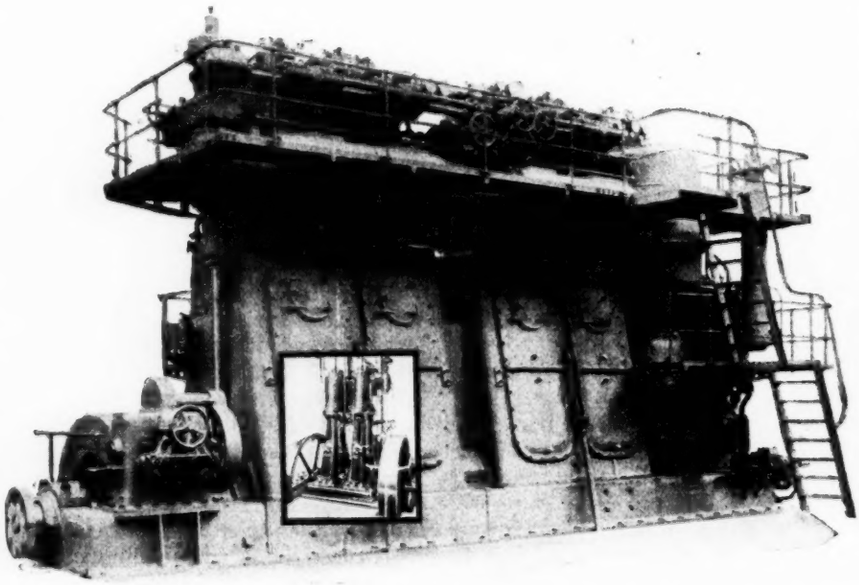


FIG. 1. MODERN DIESEL COMPARED WITH FIRST AMERICAN DIESEL

of ice. A study of Fig. 3 reveals that all the larger industries have to some extent made use of the Diesel; it is generally agreed that in every line of manufacture the oil engine is a competitor of other prime movers save in those cases where a large amount of exhaust steam is needed. American engineers have not realized upon the heat in the Diesel exhaust as have foreign engineers. Since repeated experiments have proved that 15 per cent of the heat in the fuel can be recovered in the exhaust

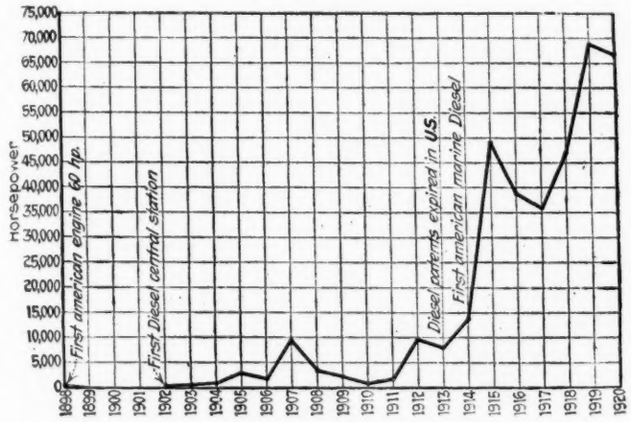
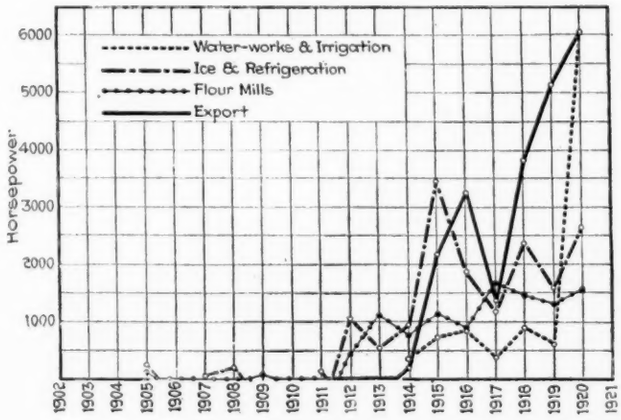
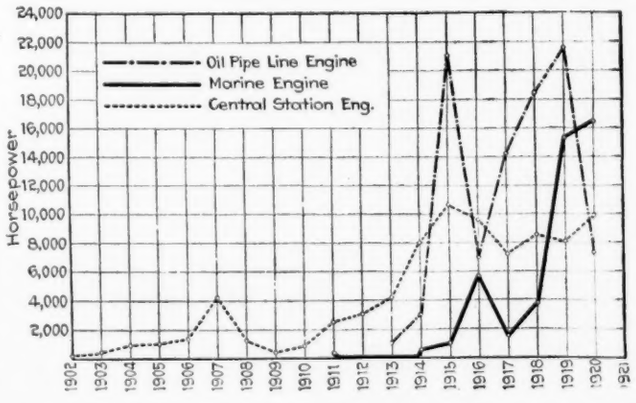


FIG. 2. YEARLY OUTPUT OF DIESEL ENGINES

together with 12½ per cent from bypassing a part of the cooling water, it is apparent that more study should be given to this point.

The territory covered by the United States is so vast that fuel-oil prices vary over a wide range dependent on the locality. Along the Atlantic seaboard the Eastern coals are cheap when compared with current fuel-oil prices, the latter ranging from eight to ten cents per gallon. This tends to discourage a general use of the Diesel in these states, although many plants are found to be operating profitably notwithstanding the high fuel prices. In the Middle West, although coal is lower in cost than in the East, fuel oil is obtainable at prices





FIGS. 4 AND 5. GROWTH OF DIESEL INSTALLATIONS IN CHIEF INDUSTRIES

that place the steam plant at a decided disadvantage. In the Eastern States the density of population and of industry is such that the central stations are of large capacities. The isolated plant, even when Diesel-driven, is sometimes at a disadvantage. Notwithstanding these adverse conditions a considerable capacity in Diesel engines is found in these states. In the Southwest the industries are not so congested and the central stations are of medium capacity. These factors, together with attractive oil prices, make the Diesel engine especially suitable for the Southwest and Central States. The map in Fig. 6 shows the number and total horsepower of the Diesel installations in each state. Five states

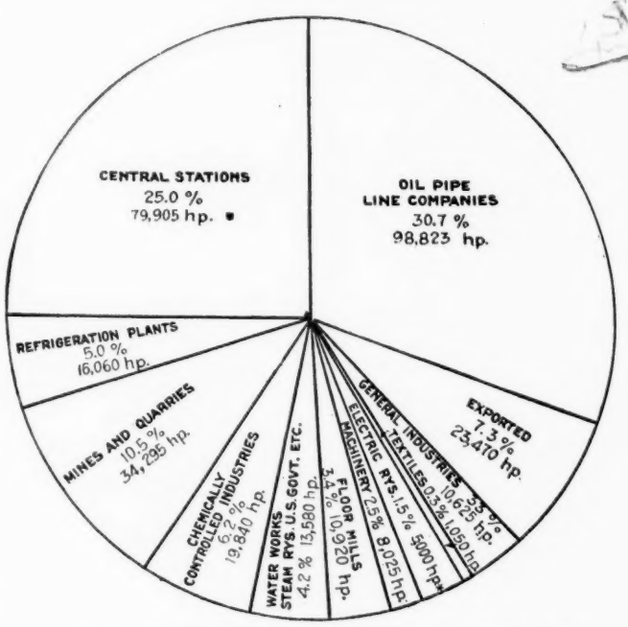


FIG. 3. DIESEL INSTALLATIONS BY INDUSTRIES

of the Central West—Missouri, Kansas, Oklahoma, Texas and Louisiana—contain one-half the Diesel horsepower of the United States.

On page 338 appears a tabulation covering all the Diesel installations by states and industries. As has been pointed out heretofore, small minor errors exist, but not to an extent that will affect the totals over one-half of one per cent. In a number of instances it has been impossible to ascertain the exact industry being served by a particular engine; these engines are placed in the column headed "other industries," although this column also covers known industries where only one or two Diesels are in use.

As might be expected, one reason for the large number of Diesel installations in the Central West, other than favorable fuel-oil prices, is the fact that in these states

Diesel-Engine Installations by Industries

State	Central Stations: Private		Central Stations: Municipal		Ice and Refrigerat'n		Oil-Pipe Lines		Irrigation & Drainage		Cement		Chemical		Iron and Steel Mfg.		Mines		Flour Mills		Textile		Gov't Inst. and Colleges		Other Mfg.		Waterw'ks and Sewerage		Total in State	
	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.	No. Engs.	Total Hp.
Maine																													0	0
Vermont																													0	0
New Hampshire	6	1,350																											6	1,350
Massachusetts			1	240	3	310																			4	480			8	1,030
Rhode Island															2	450									1	100			3	550
Connecticut																									2	400			2	400
New York	12	3,460	1	365	8	1,140							2	620	7	1,195			1	225	1	75	2	140	12	2,285			46	9,505
New Jersey			2	140	7	960							4	750							1	170			16	3,060			30	5,080
Pennsylvania							27	4,960					3	675	8	2,000					1	170	2	240					41	8,045
Maryland and D. C																									9	2,580			9	2,580
Delaware																									1	225			1	225
Virginia	1	100			6	720																	3	755	2	480			12	2,055
North Carolina																													0	0
South Carolina	1	200																											1	200
Georgia					1	200																							1	200
Florida	9	1,480	2	130	2	300							31	8,075															44	9,985
Kentucky	3	590			4	700	2	200																					9	1,490
West Virginia																													0	0
Tennessee	1	100																											1	100
Alabama	1	100																											1	100
Ohio			7	2,440			11	1,520																	1	225			19	4,185
Indiana	8	1,425											2	450	9	1,550			1	165									20	3,590
Illinois	6	1,415	5	970	3	395	3	1,550	5	3,200															1	125			23	7,655
Michigan																			1	120					2	500			3	620
Wisconsin	5	815	4	600																							2	450	11	1,865
Minnesota	5	1,250	6	1,125	2	300																							13	2,675
Iowa	1	1,075	8	1,770	1	90																							15	2,935
Missouri	13	1,855	3	330	8	2,120	16	3,583									10	1,540	3	1,140									53	10,568
Arkansas	3	600	2	620	3	760											1	140											9	2,120
Kansas	7	1,510	33	4,460	4	1,100	59	24,730			6	5,500					3	700	12	3,580									124	41,580
Nebraska	11	2,955	9	1,635	2	190													3	480									25	5,260
No. Dakota																													0	0
South Dakota	10	2,490	9	1,815																									19	4,305
Mississippi																													0	0
Louisiana	11	1,755	15	1,970	8	1,050	26	6,250	3	340					2	730													65	12,095
Texas	84	18,850	8	1,125	22	4,595	141	25,385	14	2,190	6	2,375	2	340	5	915	5	625	14	3,835	2	335	1	65			4	1,800	308	62,435
Oklahoma	7	1,730	19	3,165			135	29,085			2	520	1	250	6	3,000			4	1,375									174	39,125
Montana	1	180	1	240																									2	420
Wyoming	3	1,200					6	1,560									4	560											13	3,320
Idaho																	2	460											2	460
Utah																	3	100											3	100
Colorado			1	180													5	1,140											6	1,320
Nevada																	5	780											5	780
Arizona	23	7,090	2	100					13	775							27	13,980					2	320			5	975	72	23,240
New Mexico	2	500	4	770													22	12,680											28	13,950
Oregon																														0
Washington																														0
California	2	220	4	1,420	7	1,130			2	75			1	285			4	980			3	300			1	165	3	365	27	4,940
Alaska																	3	600											3	600
Total	241	54,295	146	25,610	93	16,060	426	98,823	37	6,580	14	8,395	44	11,445	39	9,840	94	34,295	39	10,920	8	1,050	10	1,520	52	10,625	14	3,590	1257	293,048
Marine																													91	43,690
Export:																														
Cuba and West Indies																													20	2,830
Mexico																													29	9,640
South America																													9	1,475
Philippine Islands																													8	1,680
Hawaii																													12	4,255
Canada																													4	1,800
China																													15	450
Africa, So. Sea Islands, Java, etc																													9	1349
Total Diesels manufactured in the United States																													1,454	360,217

are found a large number of oil pipe-line pumping stations. In the North Central States the Diesels are used almost exclusively in the central stations. A large percentage of the central stations in the Southwest are Diesel-engined. In the Far West the mines use most of the engines listed, although a number of small engines are found in irrigation plants. The development of irrigation projects in the Southwest will lead to a more general use of the Diesel. Large areas in Texas, New Mexico and Arizona will ultimately be put under irrigation, and pumping equipment will be necessary.

The marine Diesel industry is still in its infancy; that the marine Diesel horsepower has reached 43,690 is commendable. While the first marine Diesel was installed in 1914 and the largest units were built in 1915, there was no considerable activity in this field until 1918. There is a total of 91 American marine Diesels in service. This includes all save those in submarines; for military reasons it is obviously impossible to include the latter units.

There is every reason to expect a consistent demand for marine engines. In medium- and small-tonnage vessels they find an especially suitable field. In tank service no other form of power is so efficient. On the other hand, a large volume of marine engines, either of steam or oil, cannot be expected for several years. The world's demand for tonnage, save vessels for special requirements, has been fairly satisfied. There was less tonnage launched in 1920 than in 1919, and in 1921 a lessened amount is predicted.

The export field offers attractions to the Diesel manufacturer. During the life of the original Diesel license it was not possible to export American Diesels; consequently, the export period started in 1914. Since that time 106 engines, totaling 23,470 hp., have been sold to various countries. This does not include, however, 900 hp. which were originally in operation in the United States and subsequently shipped to the West Indies, South America and Canada.

In a number of countries—the West Indies, South America and the Orient—the scarcity of coal has created a demand for the Diesel engine. European manufacturers have had representatives in these countries for years; as a result the major part of the demand has been filled by foreign firms. A wonderful field awaits the builder of small Diesels, ranging from 50 to 200 hp.,

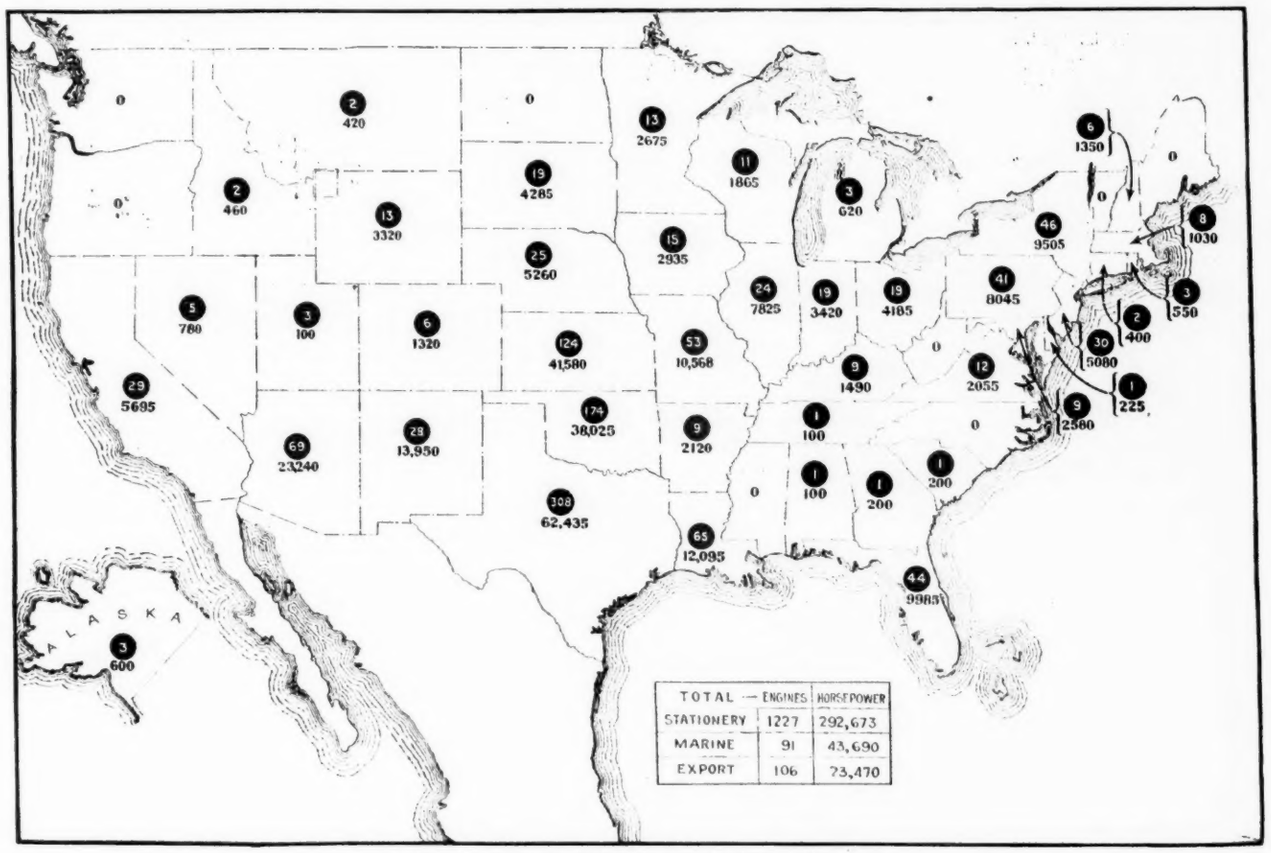


FIG. 6. DIESEL INSTALLATIONS BY STATES

to replace less efficient internal-combustion engines and small steam plants.

The sugar industry must ultimately adopt the Diesel. In former years the amount of begasse from the crushers was sufficient to meet the boiler-fuel requirements. More advanced methods of separation have reduced the begasse percentage to such an extent that enormous quantities of fuel oil are used in steam generation.

The horsepower output of the Diesel builds has shown an increase over preceding years, save in 1920. There are now some fifteen manufacturers actively engaged in Diesel-engine building while ten to twelve concerns are completing patterns or are in a position to accept orders, but are mainly engaged on other lines. There is every reason to expect over a million horsepower of Diesels in service by 1925.

In considering the choice of a prime mover for a power plant, the investigator is frequently prompted

to install other than oil engines for fear of oil scarcity. Much has been written and spoken concerning the danger of the total exhaustion of the petroleum supply. While economy should be practiced in respect to the oil-field supply, no immediate danger of exhaustion exists. At the present time there is strong indication that Canada contains a very important oil field. In Mexico, South America and the West Indies there are petroleum supplies that are still untouched.

There is no doubt that petroleum prices in the future will advance with increased consumption and rising coal prices. It is hardly probable that fuel oil will ever reach a price that would make the Diesel fuel costs higher than the costs of a steam plant in favorable localities. Recently, crude oil has been selling at one-half the 1920 quotations and fuel oil is obtainable at from 85 cents to $1.50 per barrel in the Middle West. At these prices the Diesel economy cannot be attained by any of its competitors.

Notes on Piping

By Wm. W. Edson

Run piping the shortest route with the fewest number of turns.

When in doubt as to the kind of fittings use the heavier, especially for blowoff, boiler-feed, and main steam lines.

Cut clean, sharp threads and use graphite and oil or a good pipe cement and screw up the joints tight.

Use special metal-seated unions for important positions.

If a pipe is to carry dirty water, use crosses or tees with plugs at the turn of the pipe. If a plug is to be removed often, it is better to use a nipple and a cap.

For pipes larger than 4 in. it is usually better to use flanged fittings, excepting on relatively unimportant lines or in places where there is not enough room for the flanges. Flanged fittings are easy to install and remove; leaks are easily stopped, and flanges make a stronger joint, since a pipe acts as an expander when screwed into a fitting.

The size of water piping depends on the amount of water needed, the cost of the pipe balanced against the cost of water friction, the space available, the pressure drop allowable, length of pipe, etc. For example, for 35 ft. of service pipe running from a main having 60-lb. pressure the discharge into the atmosphere would be as follows:

Size of Pipe, Inches	Discharge Cu.Ft. per Min.	Gal. per Min.
½	1.56	11
¾	4.26	31
1	8.67	65
1½	23.44	175
2	47.15	353

Velocity in the pipe should be about 400 to 600 feet per minute.

The size of steam piping will depend on the amount of steam required, length of pipe, pressure drop allowable, cost of pipe balanced against loss due to friction, space available, whether steam flow is steady, as with turbines and with engines having a large separator, or irregular, as with engines having no receivers, etc. The smaller the pipe the higher the velocity, thus the less time for condensation. Likewise the smaller the pipe the smaller the radiating surface. A 12-in. pipe has a little more than twice as much radiating surface as a 6-in. pipe.

Steam flow is usually 4,000 ft. per min. for exhaust lines, 6,000 ft. for pumps and engines, and 8,000 ft. for turbines. With high pressures and with superheat this 8,000 is exceeded. Excessive pressure drop, caused by the high velocity, will be due to friction and may produce enough heat to evaporate any condensation.

Steam pipes should slope in the direction of flow and should be well drained and trapped. One of the most important things to watch is the expansion and its handling. Use large expansion bends, several swivel thread joints, or expansion joints.

Steam piping should be covered with some sort of heat-insulating material. It should be kept dry and in good order.

Steam leaks cause a much larger loss than is usually believed. For instance, when steam costs 5c. per 100 lb. the loss is as follows:

Size of Hole, In.	Steam Lost per Month, Pounds	Loss per Year Dollars
1/16	3,400	20
3/32	13,200	80
1/8	52,500	320
3/16	210,000	1,260
1/4	470,000	2,800
5/16	835,000	5,000

Perpetual Motion Plus

A CERTAIN old lady had the reputation of never speaking ill of anyone. A friend remarked to her one day, "I believe you would have a good word to say for the Devil himself." "Well," was the reply, "I have always understood that he was a very persevering gentleman."

On Jan. 30, 1917, the perpetual-motion inventions of Messrs. Bissell and Ulram, which had previously been fully described in these columns, were discussed, analyzed, and it would seem effectually disposed of so far as practical possibility of ultimate operation was concerned.

On May 18, 1920, and Dec. 21, 1920, *Power* published full descriptions of "improved" devices conceived and perpetrated by the aforesaid gentlemen for the upsetting of the laws of gravity and friction, Mr. Ulram having in the meantime transferred his activities from Detroit, Mich., to the more susceptible field of Jersey City, N. J.

And now Mr. Bissell, of Pittsburgh, submits a new design exactly the same in principle as that already illustrated, which he states is "much more efficient" and, once started, will really "*go*." Why attempt to gild the rose? What is twice nothing?

So far as known to the writer, Mr. Bissell has organized no "corporation," solicited no funds from the public, and given no evidence of being other than a sincere gentleman engaged in the more or less pleasurable but equally unprofitable occupation of chasing bubbles.

But what a waste of time, effort and ingenuity! Cannot some one invent a machine to turn such perseverance into practical channels? Then, indeed, the chimera of perpetual motion might seem more believable.

Up to the present time there has been built and installed in this country approximately 225,000 hp. capacity in unaflow steam engines.

Inspection and Care of Electric Motors

Importance of Regular Inspection and Record-Keeping System—Forms Submitted for Reports—Cleaning of Motors—Care of Connections and Bearings—Inspection and Testing of Insulation—Importance of Periodic Overhauling and Inspection of Controlling Apparatus

By H. M. PHILLIPS
Electrical Aid, Public Works Department, Washington Navy Yard

IT HAS been amply demonstrated by many of the largest users of electric power, in both large and small units, that the periodic inspection, cleaning and overhauling of motors is a paying proposition. In some cases very elaborate systems of record keeping have been devised and found to be justified. Smaller organizations, where equally beneficial results might be obtained with a much less expensive system, frequently assume that no system at all is necessary because they have only a few motors, and are prone to let these go their own gait until a breakdown occurs. It is a matter of importance that there should be a system, however simple, under which motors are inspected and a report on their conditions rendered at regular intervals. A report should also be made on each occasion of interruption of service. Even if the chief electrician and oiler makes out this report to himself and files it in his tool box, it is of value. He will be less likely to forget when he last went over the motor or to postpone the inspection from week to week on account of pressure of other work. Simple forms, as illustrated in Figs. 1, 2 and 3, to be filled in at the time of inspection or after a breakdown, on which the more important points can be checked off individually, are likely to give better results than a simple "O.K." on the motor as a whole. Form *A* is suitable for use by a man somewhat above the average intelligence who has a comparatively small number of motors to care for; it is in the nature of a personal memorandum. The size might be 5½ x 8½ in., although it is advisable to allow plenty of space. Many forms of similar nature lose much of their value by being too small. Form *B* is for larger plants and men that may be of somewhat lower intelligence. For most of the items it is only necessary to put a check mark or O. K. in the spaces provided or one or two words where conditions are unsatisfactory. It is considered desirable to use a full-sized sheet for this form and to provide the inspector with a sheet of fiber and heavy paper clips for carrying it. Form *C*, for use in case of interruptions of service, should also be on a full-sized sheet. The frequency of the reports may vary from each 24 hours to 90 days, according to the location of the motor and the importance of the work, but their regularity should be considered a matter of prime importance. Cleanliness, although always necessary, is likely to be superficial as to the results attained. All insulating washers and bushings should receive individual attention; the careless use of a wiping cloth is more likely to deposit dirt at these most essential points than to remove it. The lower brush-holder stud is sometimes a little difficult to reach, but should receive special attention on account of its liability to collect dust and oil. The use of compressed air at a pressure of from 60 to 90 lb. is likely to release a gratifying amount of dust, but it has its dangers. It is quite likely to carry a dangerous amount of moisture, has some tendency to loosen weak insulation and may even drive carbon and copper dust into recesses in the insulation that would otherwise remain clean. The use of the old-fashioned bellows is to be preferred in many instances;

Form A.

MOTOR INSPECTION

Date_____

Make and Horsepower_____

Serial or Shop No._____

Location_____

Date of Last Inspection_____

CONDITION AS FOUND
Connections, Commutator, Oil, Insulation, Starter, Etc.

Work Done

Further Attention Needed

FIG. 1. FORM A FOR MOTOR INSPECTION REPORT, SUITABLE FOR SMALL PLANT

if compressed air is to be used, it should be with considerable caution.

In addition to the foregoing all lead wires and connections should be examined for chafing of insulation, poor contacts or broken strands at each regular inspection of the motor. The oil should also be brought to the proper level in the wells and the condition of the commutator and brushes noted. In the majority of cases it is unnecessary to drain the bearings at each inspection, but it is quite essential that it be done at regular intervals; the armature clearances should be checked at the same time. No motor can do its best with the armature or rotor off center, and the renewal of bearings should not be delayed until there is danger of contact with the stationary parts. The permissible variation of air gap will depend on the type and size of the motor; with the exception of induction motors with very small clearances, the maximum gap should not exceed the minimum by more than 25 per cent on the average motor. Dustproof bearings are advisable in nearly all locations and necessary in many; if they have not been provided by the manufacturer, it is usually possible to secure felt washers to the bearing housings in a manner that will give very good results. Measurements of insulation resistance, by the use of a direct-current voltmeter of the "Megger" type are valuable in many cases, but difficult to interpret. A high resistance is not necessarily an indication of good insulation, as the most minute air gap or film of good insulating material between a conductor and ground is sufficient to give this result; yet it may break down entirely under vibration in service or movement of parts due to change of temperature or load. A very low resistance approaching a dead ground is a safe indication of trouble of some sort, but the cause and seriousness of resistances much below normal are largely a matter of conjecture. There is likely to be a very large difference in resistance with temperature, but the coefficient of resistance is so variable that it is impossible to make a correction for it. A slight amount of moisture, due to humidity of the air, a minute quantity of water accidentally splashed upon a winding, or insulating varnish that has not been thoroughly dried, may produce a marked reduction. It is impossible to fix any definite value of insulation resistance as indicating a danger point; it is really a measurement of the possibility of leakage of current from the windings to the frame of the machine. The same leakage may be distributed fairly uniformly over all the insulating material in the machine and be entirely harmless; or it may be concentrated within a very small area where the heat generated, or electrolysis, will be sufficient to cause a speedy breakdown. The ordinary motor, when new and thoroughly dried out, is likely to show 40 or more megohms, too high a value to be read by the voltmeter method; the American Institute of Electrical Engineers specifies a value in megohms, not less than the voltage of the machine divided by its kilovolt-ampere capacity plus 1,000; $\frac{V}{(KVA + 1{,}000)}$. For a 220-volt motor, assuming 10 kva. input to the machine, this would give $\frac{220}{10 + 1{,}000} = 0.2$ megohm, approximately; lower values on motors in service are pretty sure to be

Form B.

MOTOR INSPECTION

Date _____

Make and Horsepower _____

Serial or Shop No. _____

Location _____

Date of Last Inspection _____

CONDITION AS FOUND

Motor

Contacts and Connections: Tight _____ Cool _____

Commutator: Smooth _____ Clean _____ Cool _____

Brushes: Contact _____ Length _____ Movement in Holder _____

Oil: Quantity _____ Appearance _____

Bearings: Cool _____ Rings Free _____ No Oil Escapes _____

Armature Clearance: Uniform _____ End Play _____

Insulation: Clean, Dry, Unbroken _____ Brush Rigging _____

Commutator _____ Terminals _____ Windings _____

Controller or Starter _____

Operation O. K. _____ Contacts _____ Clean _____ Smooth _____

Insulation _____ Clean _____ Dry _____ Unbroken _____

Connections _____ Tight _____ Cool _____

Wiring _____ Properly Secured _____ Clean and Dry _____

Safety Devices, Circuit-Breakers, Etc.

Operate Freely and Correctly Adjusted _____

Parts Renewed _____

All Parts Thoroughly Cleaned _____

All defects noted above have been remedied, except as noted below _____

The following should have further attention _____

Is there excessive heating or other indication of overload _____

If any other work is advisable, describe same, using back of sheet if necessary _____

Signed _____

FIG. 2. FORM B FOR MOTOR INSPECTION REPORT, SUITABLE FOR LARGE PLANT

due to moisture or dirt rather than to any defect in the insulating material.

Where reliable service is of the utmost importance, insulation resistance should be measured at frequent intervals (not less than once a week) and a curve plotted with the values obtained; if the curve shows a falling characteristic, a determined effort should be made to locate the cause, and if it cannot be remedied, preparations should be made for the final breakdown. When a machine has been exposed to moisture, some idea of the safety of starting up without preliminary drying may be obtained by a measurement of the insulation resistance; one may feel moderately safe, especially with voltages below 500, with an insulation resistance as low as one-third the value required by the A. I. E. E. formula. With still lower values there is probably an element of risk, although it is entirely possible that the motor may be operated without damage with the resistance far below the standard. Measurements of insulation resistance are also useful while apparatus is being dried in the oven; small dependence can be placed on the absolute values obtained, but the variation in resistance at intervals of two or more hours and at the same temperature indicates the progress of the drying process.

A general overhauling of the motor at regular intervals is undoubtedly profitable. Under exceptionally severe operating conditions, such as exposure to moisture, overloads, excessive vibration, fumes or oil in the surrounding air, it may be advisable to fix the maximum interval at once a year. In some cases the practice is every three or four months. Under ordinary conditions once in three years is likely to be sufficient. Armatures should be thoroughly cleaned, dried out at a temperature not exceeding 90 deg. C. and treated while still hot with a thin insulating varnish. Dipping is preferable, but satisfactory results may be obtained by spraying or the careful use of a brush. It is advantageous to have the armature hot when the varnish is applied and it is best to dry the varnish in the oven before putting the motor in operation. Field coils should be given practically the same treatment as the armature, with special attention to the fiber or similar insulating material about the head and core. Gasoline in small quantities is a valuable cleaning agent; warped or cracked insulation should be replaced, patched or filled with a hard wax and varnished. Special attention should be given the insulation of the lead wires at the point of entrance to the coil. All insulating washers and bushings should be removed, cleaned and varnished. Controlling apparatus should receive much the same treatment as the motor. Contacts should not be allowed to go from bad to worse. Accumulations of dirt about the resistance units form a serious fire risk. Where regular inspection is neglected, a surprising number of overload and no-voltage relays, together with other protective or regulating devices, will in general be found to be inoperative.

Form C.

INTERRUPTION OF SERVICE

Date_____

Make and Horsepower of Motor_____

Serial or Shop No._____

Location_____

Duration of Shut Down_____

Date of Last Inspection_____

Date of Last Shut Down_____

Direct Cause of Shut Down_____

Contributing Causes: (Give full details; if overload, how did it occur and why protective devices failed; if oil or water, how they reached part affected)_____

Could trouble have been prevented? How?_____

Are other motors liable to same trouble?_____

Signed_____

FIG. 3. FORM C FOR REPORT ON INTERRUPTION OF SERVICE

No system is infallible, and the fact that one motor may run for five or more years with practically no attention while another is in frequent trouble in spite of the best of care can usually be attributed to operating conditions, which should receive careful study; less frequently to radical defects in design or construction, which may sometimes be remedied without great expense; as a last resort we may say that it is simply

"luck," good or bad; but under no circumstances should a few isolated cases of this nature be claimed to show the futility of the inspection system, for it is bound to pay in the long run. The cost of repairs is in general not the most expensive item in the failure of a motor, but the loss of production due to the motor and machine it is driving being out of service.

Refrigerating Plant Troubles

By J. C. Moran

The engineers in a small cold-storage plant were having a lot of trouble in keeping down the temperature in one of their sharp freezers. For some reason or other it seemed impossible to get one of the coils frosted, and furthermore, whenever this coil was turned on, the ammonia gradually disappeared from the receiver. Finally, after the ammonia had all gone from the receiver and the machine had operated in this manner for an hour or so, the machine began to frost back heavily and the discharge line got icy cold. Several times there had also been heavy thumps in the compressor, indicating that there was considerable liquid coming back with the suction gas.

The trouble had appeared gradually, showing up slightly in the later part of the summer season and gradually getting worse as cold weather set in. The cooler had two large coils—the one just mentioned, which seemed to be giving all the trouble, and another of the same size, which barely maintained the temperature in very cold weather when working alone. Turning on the second coil seemed to help matters very little if at all.

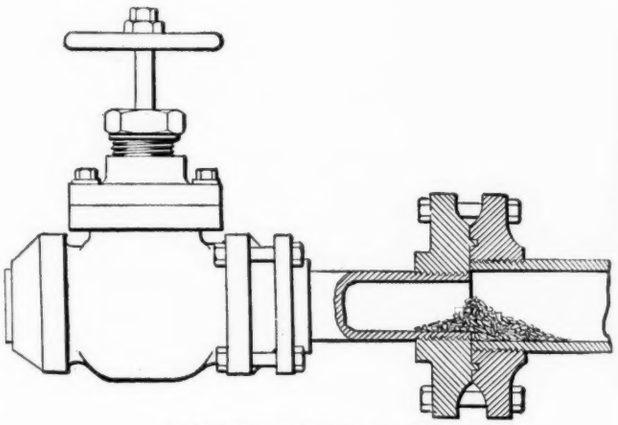
In starting the coil at any time, the usual sizzling noise made by an expansion valve that is working properly was heard, but after the coil had been in operation a short time, the sound gradually died down and finally stopped altogether. Opening up on the valve failed to help matters any, and only by shutting off the valve entirely and leaving the coil out of service for several hours was it possible to get it to start properly again. After every man in the small town where the plant was located who knew anything at all about engineering and refrigeration had his try at it, the manufacturer that had installed the machine was asked to send a man to see what he could find out about it.

After fussing with the troublesome coil for about a day, the manufacturer's expert finally decided to shut the coil off, pump it out and open it up to see if there was anything wrong inside. When he cut out the coil at the suction end he found that the pipe had been reduced to 1¼ in. where it connected to the stop valve, most likely to cut down the cost of valves. After the coil had been pumped out, it was disconnected at this point.

The coil was made up of 2-in. pipe up to the point of the reduction, which had been made with a reduced flange, making a sharp shoulder as shown in the sketch. Evidently, the pipe had not been blown out after it had been installed and scale, pieces of pipe threads, burrs from the frayed edges left by the pipe-cutting tool and other foreign matter had accumulated at this point until the pipe was practically stopped up.

It was a simple matter to remove the scale and other foreign matter from the end of the coil, and then the last section of the coil was disconnected entirely and blown out by air. To prevent any possibility of further trouble from this cause, 2-in. pipe and a 2-in. valve were substituted for the old 1¼-in. connection.

The solution of the puzzle was now quite simple. The obstruction in the coil was sufficient to choke off the outflow of gas from the coil to the suction line and, as a consequence, a high pressure was built up in the coil; in fact, it is probable that the pressure built up to nearly that in the liquid line feeding the coil. At any rate, with the increase of pressure in the coil the temperature of the ammonia also increased. A suction pressure of five pounds was carried on the system on which the freezer was operated, which corresponds approximately to a temperature of 17 deg. below zero. The room was held at from 5 deg. below zero to zero, and when the pressure in the coil built up so that the corresponding temperature was above this point, the action of the coil would be reversed and instead of absorbing heat it would give it out and act as a heating coil. This would take place at any time when the pressure in this coil built up to a little above 15 lb., when the ammonia would have approximately the same temperature as that of the room if the latter was held at zero, and of course no heat transfer would take place.

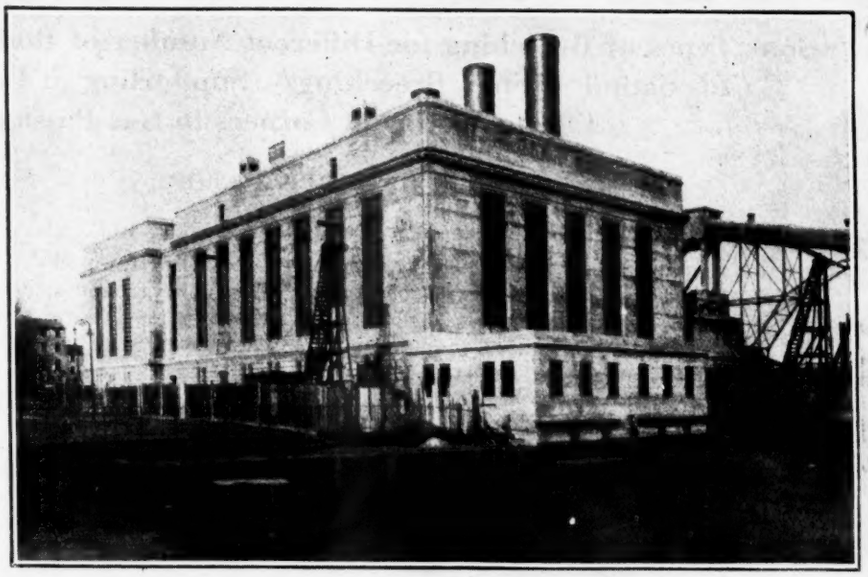


STOPPAGE OF OIL BY DIRT

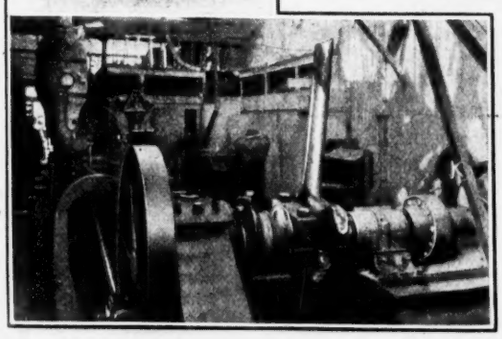
Since the pressure on the liquid line was somewhere around 150 lb., it can be easily seen that, with the outlet practically choked off, it was quite possible that the pressure in the coil might be 100 lb. or more at times, depending of course on how badly the outlet was choked off. At a pressure of 100 lb. the temperature of the ammonia in the coil would be about 65 deg., which would cause the coil to thaw off and act as a heating coil, giving up heat to the room instead of cooling it. This also explains where the ammonia went to when it disappeared from the liquid receiver.

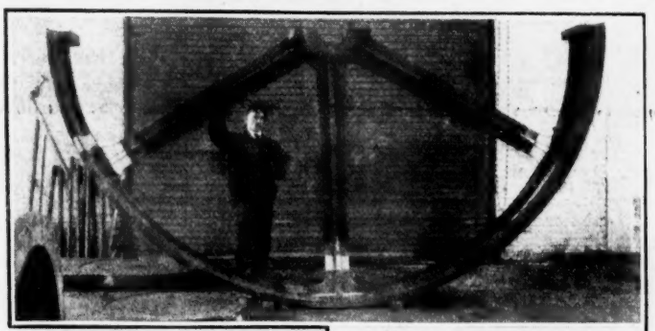
The coking of a ton of high-grade coal in a beehive oven requires the consumption of 11,000 cu.ft. of gas, 9 gal. of tar, 4 gal. of light oil and 100 lb. of coke, which, in all, generate 9,388,000 B.t.u., or the equivalent of 671 lb. of coal. The byproduct oven in making a ton of coke uses 4,300 cu.ft. of gas, which is equal to 2,408,000 B.t.u., or equivalent to 172 lb. of coal. The beehive oven in making a ton of coke consumes 33.5 per cent of the heating value of the coal, while the byproduct oven requires only 8.6 per cent. In 1918 there was coked in the United States 48,168,719 tons of coal. If this had been coked in byproduct ovens there would have been a saving of approximately 25 per cent.

The recently completed 60,000-kw. Delaware Station of the Philadelphia Electric Co. The plant will ultimately have a capacity of 180,000 kw., and is built of reinforced concrete throughout.



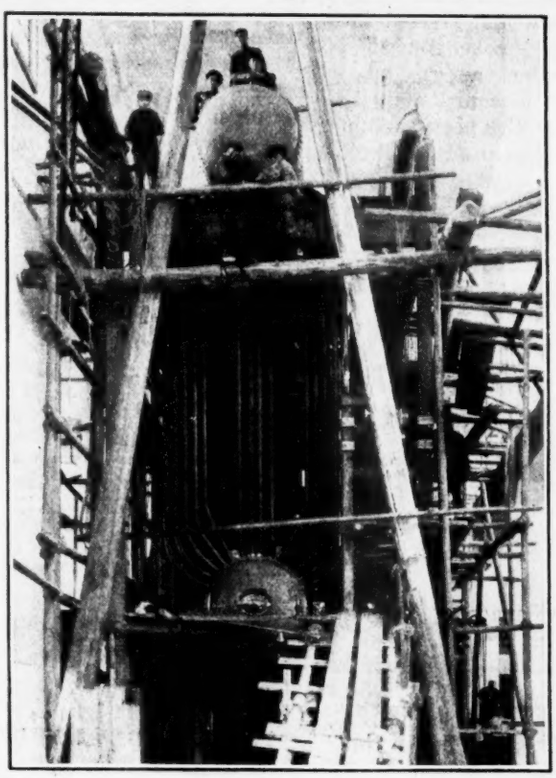
Wreck of a flywheel at Stuttgart, Arkansas. The governor rod broke and the head end of the engine took steam for practically full stroke.
Courtesy "The Locomotive."



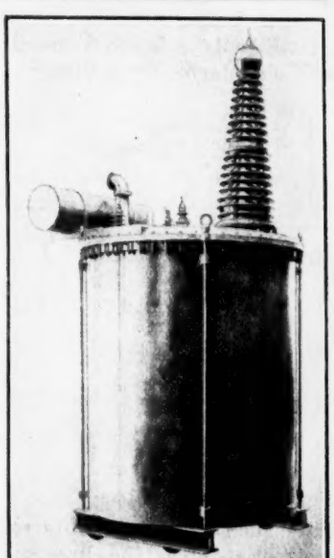


This 18-ft. flywheel broke in four places and was repaired by oxy-acetylene welding in 57½ hours.

大正八年拾弐月四日撮影
七〇九馬力
瀘鑵組立側面圖



One of ten water-tube, Erie City Iron Works boilers, with a total of 71,180 square feet of heating surface, being installed in the Fukuzaki Steam Plant of the Ujigawa Electric Co., Osaka, Japan.



One of four 220,000-volt, 8,333-kva. G.E. transformers for the Southern California Edison Co.'s "Big Creek No. 8" hydro-electric plant.

Chimneys—Breeching Construction*

Various Types of Breeching for Different Number of Boilers Are Discussed—Insulation of Steel Breechings—Supporting of Breechings—Effects of Abrupt Corners in Gas Passages

BY TERRELL CROFT

THE "smoke conduit," as used in this article, designates the smoke passages between the boiler or boiler setting and the chimney. Such connections are designated in various ways by different writers and manufacturers. A smoke conduit may be made of any suitable material. The most common is sheet or plate steel, which is formed and riveted into the desired shape. But where the smoke conduit is large or is supported on or is under the ground, it may be of brick, concrete or other masonry material, which will not be injured readily by the heat and flue gases. The term "breeching" shall be used herein to indicate such smoke conduits as are made of sheet or plate steel. When the breeching is vertical or at a steep angle with reference to the horizontal, it may be called an uptake. An example is shown in Fig. 1, where the stack is connected to the smokebox by the vertical, oval, conical uptake breeching. A "smoke connection" is a simple approximately horizontal breeching which leads directly from the boiler into the chimney. Such breechings are used often in heating-boiler installations. An "underground smoke conduit" is one through which the combination gases are carried underground to the chimney. Such conduits are seldom installed, except where it is necessary to satisfy some special requirement.

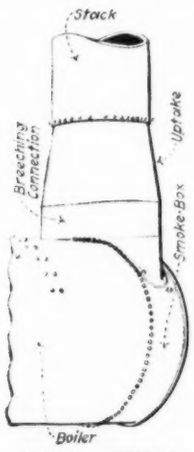


FIG. 1. SIMPLE BREECHING

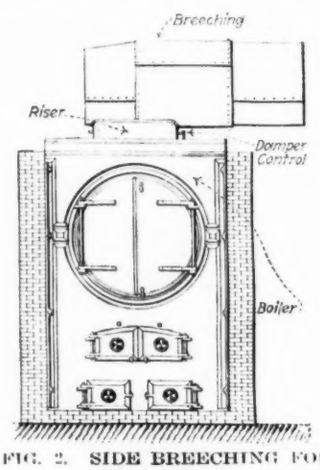


FIG. 2. SIDE BREECHING FOR ONE BOILER

Underground smoke conduits are undesirable. It is difficult to clean them, and, furthermore, the gases passing through may be chilled and hence the effective draft pressure is decreased. The cleaning of the breechings above the ground is easily effected through the doors which may be provided. If water can get into the underground conduit, it will evaporate and cool the gases as they pass through, thus taking away the draft power of the gases.

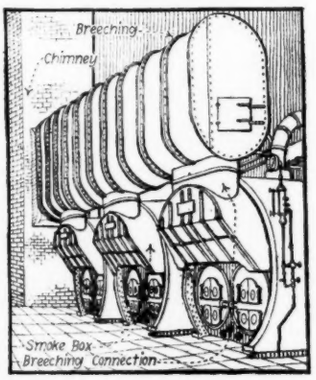


FIG. 5. TRIPLE SIDE-BREECHING ON THREE BOILERS

A common type of breeching connection for one boiler is shown in Fig. 2, and is called a side breeching, since it leads horizontally to the chimney. The riser is oval in section and the horizontal conduit is circular. Note that the damper is in the riser. The arrangement of the breeching where two boilers are served by one chimney, may follow any one of a number of different designs. Which of these should be adopted in any given installation must be determined by a consideration of the local conditions that must be satisfied. Two different designs are shown in Figs. 3 and 4.

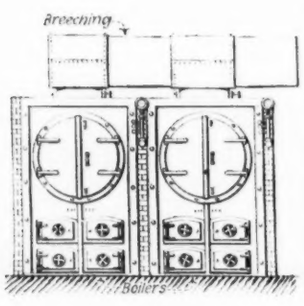


FIG. 3. BREECHING FOR TWO BOILERS

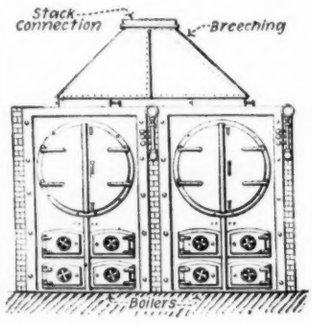
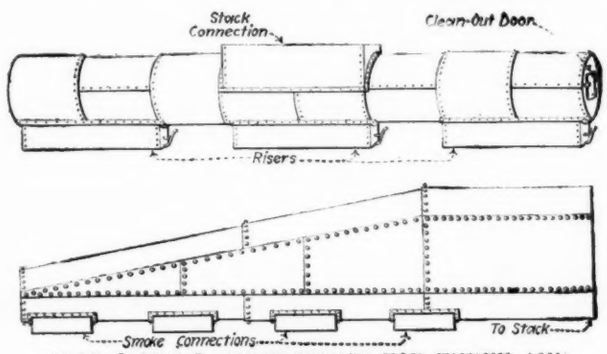


FIG. 4. INVERTED Y-TYPE BREECHING



FIGS. 6 AND 7. BREECHINGS FOR THREE AND FOUR BOILER

Fig. 6—Center-connection triple breeching. Fig. 7—Horizontal breeching for four boilers.

Figs. 5 and 6 show breeching arrangement where three or more boilers are connected to one chimney. Fig. 5 shows a triple side breeching, while in Fig. 6 a triple breeching with center entrance to the stack is shown.

*All rights reserved. This material constitutes part of the author's forthcoming book, "Steam Boilers."

When a breeching of the type of Fig. 6 is used, unless the dampers are adjusted carefully, the center boiler is liable to have the best draft pressure. In Fig. 9 four boilers set in pairs, have a common chimney connection through two double side breechings. Note that the stack does not rest on the breeching, but is separately supported. With the side breeching for four boilers, Fig. 7, the section is oval, as for similar type arranged for the double and triple connection.

In designing breechings, shapes that have sharp bends should be avoided. Sharp bends cause an unnecessary loss of draft pressure, thus making it necessary to install a stack higher than would otherwise be required, to overcome their effect. Figs. 10 and 11 indicate the results in a double-outlet breeching when the corners are square and where they are rounded. Fig. 12 shows the effect of a sharp angle where an uptake joins a horizontal breeching. The area is much restricted and the effective draft pressure is reduced. Fig. 13 shows the gases passing without interruption. The path of the gases into the stack may be improved by having (instead of the straight baffle, Fig. 8 II) a curved baffle as in Fig. 8 I.

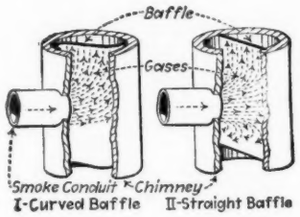


FIG. 8. UNION OF SMOKE CONDUIT TO STACK

A smoke conduit of round cross-section carries more gas for the same area than does a square one. If tested, it would be found that the gases in the corners of the square conduit would be practically stagnant for some distance out from the corner. A curve indicating the velocity of the gases would rise slowly, as in Fig. 15. This means that the average velocity of the gases is lowered for the whole area, consequently the volume of gas that passes is decreased. In the round conduit the gas is stagnant only along a thin film at the periphery of the passage, and the velocity curve rises rapidly, as in Fig. 16. The average velocity of the gases is decreased but little, hence the amount of gas passing with the same draft pressure is greater than for the square section.

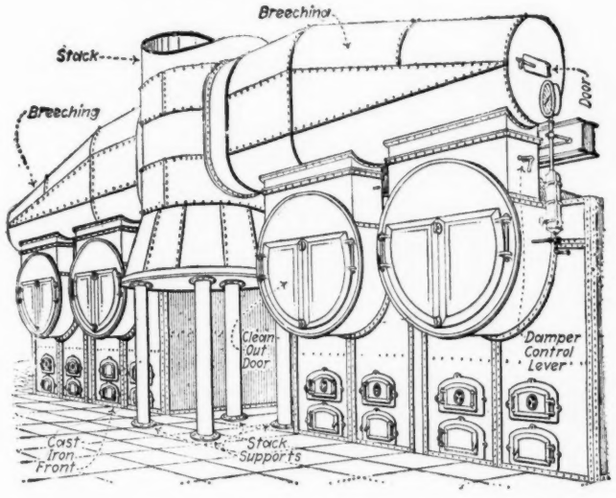
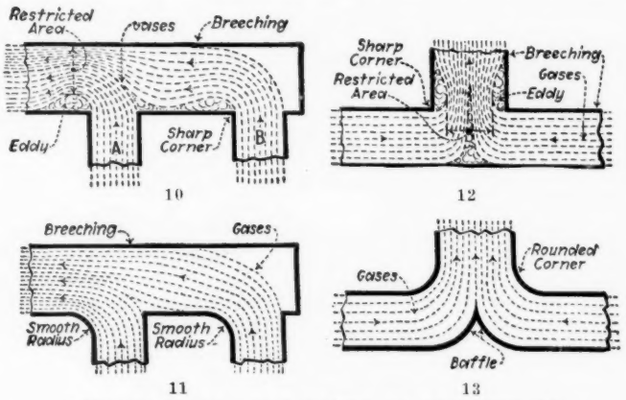


FIG. 9. FOUR BOILERS CONNECTED TO ONE STACK

Area of the smoke conduit should not be changed abruptly. Such a change will cause a decrease in the draft pressure. The area of the smoke conduit is usually greater than the opening in the chimney by at least 10 per cent. Misostow (*The National Engineer*, February, 1913) specifies an area of smoke conduit at least 25 per cent greater than the tube or flue area.

Steel smoke conduits should be covered to prevent radiation of the heat of the gases. When the flue gases are cooled, the difference between the density of the gases and that of the outside atmosphere is decreased, hence the draft pressure is reduced correspondingly. A lining may be placed inside of the breeching, but one so located is difficult to repair and keep in place. An outside heat-insulating covering is preferable. Steel smoke conduits are preferable to those of brick or concrete because the friction of the flowing gases on the steel is less than that on the other materials. Furthermore, the steel interior surface is smoother and may be cleaned more readily than can brick or the rough masonry.



FIGS. 10 TO 13. GAS PATHS IN BREECHINGS

Fig. 10—Gas path in square-corner breeching. Better draft in *A* than *B*. Fig. 11—Gas path when breeching has curved unions. Fig. 12—Effect of square-cornered riser from horizontal double breeching. Area restricted. Fig. 13—Breeching which conducts gases along smooth path.

The steel-plate thickness used for a breeching should be determined by local conditions. If a tall stack is to rest upon the breeching, it should be made of material heavier than would otherwise be necessary and it should be braced with angles so arranged that the stack will be well supported. The riveting is about the same as for the stack. Care must be taken that all seams are well closed, for leakage decreases the effective draft pressure.

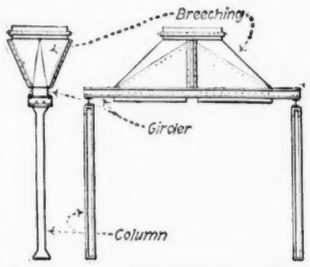


FIG. 14. BREECHING AND STACK SUPPORT

Ordinarily, breechings are made of No. 8 (0.172 in.) and No. 10 (0.141 in.) U. S. standard gage steel plate. For small work No. 12, 14 and 16 gage plate may be used. Best construction calls for $\frac{1}{16}$-in. plate, and some concerns will use no plate thinner than this. It costs but little more than lighter stock and has a much longer life, particularly when exposed to extreme conditions. Rivet diameters for plates of the different thicknesses are usually: No. 14 and 16, $\frac{1}{4}$ in.; No. 12 and 10, $\frac{5}{16}$ in.; No. 8, $\frac{3}{8}$ in. and $\frac{3}{8}$ in. The pitch is usually

about 3 in. unless the breeching must support an external load, in which case correspondingly smaller pitches should be used.

When the stack rests on the breeching, the weight of the whole should not be supported by the boiler shell. If the stack is heavy, the smokebox extension may collapse. A stack and breeching support of some description should be used. Fig. 14 illustrates such a support, the girder of which bridges the boiler. The weight is assumed by the girders and the columns at the sides.

Draft pressure should be controlled by damper adjustment. Often combustion is regulated by means of the draft door or by the amount of air that is admitted to the combustion chamber. The resulting combustion

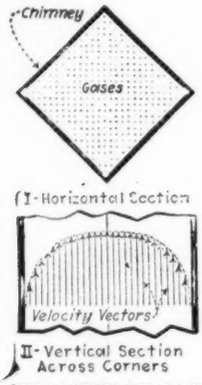


FIG. 15. VELOCITY OF GASES IN SQUARE FLUE

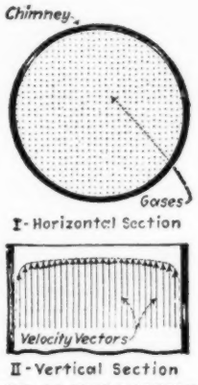


FIG. 16. VELOCITY OF GASES IN ROUND FLUE

may be poor, as compared to that which may be attained with proper damper control.

A damper is usually placed in each smoke conduit or riser so that the draft pressure in each boiler may be controlled individually. By referring to the accompanying illustrations of breechings, it will be seen that the location of the damper is generally in the riser leading into the main part of the breeching. However, in some cases the damper may be in the breeching where only one boiler is used or for two boilers if the stack connects to the center of the breeching. The damper may also be located in boiler setting just in front of where the breeching proper begins.

Preventing Instrument Transformer Burnouts

Some engineers contend that if instrument voltage transformers are properly tested by a high-voltage insulation test, it is not necessary to place fuses in the primary side. That this is not always true, however, is shown in Fig. 1. Here a burnout was caused by a metallic streak in the micarta faceplate of a portable voltage transformer. The transformer was connected to a 4,400-volt circuit, when suddenly a flame and arc shot across the two terminals right through the micarta. The outer shell was removed to show the course of the breakdown.

In Fig. 2 is indicated the result of a short-circuit on a potential transformer, which was located in a walled-in compartment. The resulting explosion blew the transformer apart and blew the compartment door off its hinges and fully twenty feet across the room. This could have been prevented by placing a resistance of 30 or 40 ohms in series with the primary, preferably half of the resistance in each leg and fusing with about a 10-ampere fuse. This resistance limits the current during a short-circuit to a reasonably low value of 50 to 100 amperes instead of several thousand, and the fuse can break this current with safety.

It would appear on first thought that this resistance would change the ratio and phase angle of the trans-

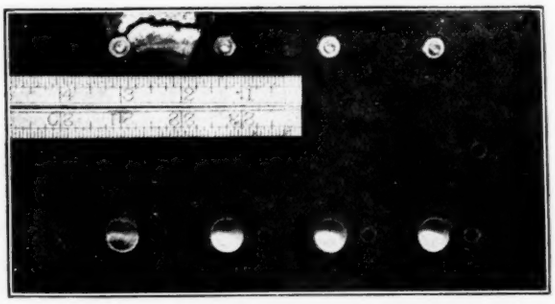


FIG. 1. FAILURE IN TRANSFORMER TERMINAL BLOCK

former, but in actual practice the error is almost negligible. For instance, if a 2,000- to 100-volt transformer takes 10 milliamperes in the primary, with a secondary load of 10 watts, and the resistance of the primary is 1,200 ohms, the total impedance across the primary circuit would be 200,000 ohms. Now if 40 ohms be inserted in series, the drop across it will be only 40 ×

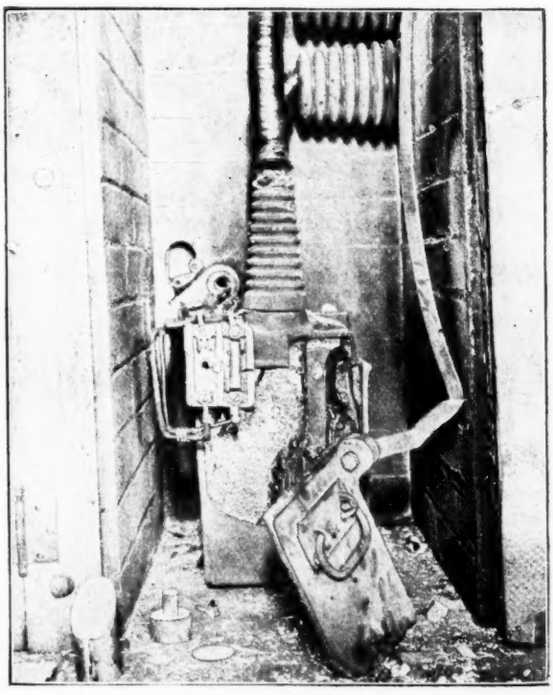


FIG. 2. RESULTS OF TRANSFORMER FAILURE

0.01, or 0.4 volt, which figures, roughly, an error of 0.02 per cent.

In the same way, figuring out the phase angle by laying off triangles with 200,000 as the hypotenuse and 1,200 and 1,240 as one side, it will readily be seen that the difference between the two triangles is only a fraction of a degree.

Efficient Handling of Fuel Oil—VIII

By ALLEN F. BREWER

BY THE layman the question of oil storage is generally looked upon from one of two extreme angles—either as a most hazardous proposition or as so simple a matter as to be worthy of little consideration. To a certain extent both views are reasonable—the former, if accompanied by gross carelessness; the latter, if over-extreme care is used. A happy medium can well be arrived at by guarding constantly against the careless idea and tempering the amount of caution to be observed with good judgment and common sense.

The purpose in this article is to set forth the dangers that may be possible, and the results that may occur, due to negligence and carelessness in the storage of oil fuel. Then, from the opposite viewpoint will be stated the common-sense facts which accompany the proper storage of such fuel and make it the most desirable and in truth the safest fuel to store over any length of time, in practically any locality and in the most adaptable space.

In order to understand and appreciate the dangers that may arise, and the necessity for care in the storing of fuel oil, its physical characteristics, which are the roots of such dangers, must be considered. Under normal temperature conditions fuel oil is a heavy, viscous, non-explosive fluid, being either crude oil in a pure state, or the residue or distillate of petroleum after the removal, by distillation, of such lighter components as naphtha and gasoline. Fuel oil is not subject to spontaneous combustion nor will it ignite when in bulk form. The primary danger is due to the tendency it has to vaporize, especially under higher temperatures, and form an explosive mixture with air.

This article sets forth the danger that may be present and the results of negligence and carelessness in the storage of fuel oil, and explains the precautions to be observed to assure proper storage, which make it the safest fuel to store for any length of time.

As a general rule no extensive amount of explosive gases will occur unless the oil be heated close to its flash point. We are, therefore, faced with one primary principle—*keep the temperature in the storage tank as low as possible and still get proper pumping and flow. Never let it exceed the flash point.* The flash point is generally taken as a measure of the fire hazard, because fuel oil must be heated to this temperature before explosion (if exposed to spark or flame) can occur in the body of the oil.

Cautions To Be Observed

Allow no naked light, smoking, electrical apparatus, or tools liable to cause sparks, within at least fifty feet of an oil tank, vent or hose when oil is being delivered.

Never allow such lights or apparatus in any tank or space where oil has been stored, until the former has been flooded with water or steamed and thoroughly ventilated.

Allow no person to enter an oil tank until it has been well ventilated, and, if possible, steamed or flooded; and when he enters such a tank he must have a lifeline firmly tied to his body and properly attended by a man on the outside. This is to insure prompt rescue if he is overcome by gas.

Never allow a man to work alone in an oil tank.

Never fill a tank with oil until it has been tested, drained and cleaned. Remove all dirt, sand, sludge, wood, bagging, sawdust, tools, etc., and sweep the floor clean.

Inspect frequently for leaks in the tank seams, piping, etc. Allow no leak to continue if it can possibly be corrected. If not stopped, it will surely result in an explosive vapor being formed and collected, with the ever-prevalent danger of fire if a spark or flame should reach it.

Wipe up spilled or leaked oil promptly. Remember, leakage from oil piping, particularly if the oil be heated and under pressure, may occur as a spray, which will have an even greater tendency than liquid oil to mix with air and form an explosive gas.

In order to be sure of constant and uniform flow of fuel oil from the storage tank whatever the weather conditions, a heating coil should be placed in the tank. The general idea is usually as indicated in the illustrations. Fig. 1 shows the principle of surrounding the suction pipe with a small steam coil of ½- to 1-in. pipe. A dozen or more coils, depending on the weather temperature and the usual gravity of the oil, will generally be sufficient. It must be remembered that it is not necessary to heat all the oil in the storage tank prior to pumping to the burners. If done, this is wasteful of heat units and not beneficial to the burning to any extent.

Fig. 2 shows a horizontal type of pipe coil, usually located within two or three feet of the tank floor. It can be built of standard 2-in. pipe and fittings. No expensive labor is necessary, and hence it is perhaps the cheapest and most adaptable for the small plant.

Whatever the method of heating, exhaust steam should be used. It contains very nearly as much heat as does live steam and is the most economical.

Both the foregoing methods of arranging heating coils can be used in either horizontal or vertical steel tanks or in concrete tanks, the fittings and pipe lengths being changed very little. The design and calculation of heating coils is a problem for the engineer and not within the fireman's range of duties.

Construction of Storage Tanks

While the construction of storage tanks will not be included in the duties of the average fireman, nevertheless there are certain points that should be of interest to all.

Tanks may be built of steel or concrete. Heretofore, the concrete tank has been an experiment, but today it is coming more and more into favor, particularly where tankage must be located underground and in

locality where fire regulations are rigid. There are three strong arguments in favor of concrete as a material for tanks—permanence, strength and freedom from corrosion.

Other points that decidedly favor the concrete tank for underground service are, that in such a tank, covered with about three feet of earth, the oil therein is kept at a fairly uniform temperature, there is little or no danger from lightning, oil loss by vaporization or leakage is cut down to a minimum, and insurance rates on surrounding buildings are not materially raised. Furthermore, valuable yard space is not taken up by the tank, it can be built on the plant with practically unskilled labor, and it is not affected by salt water or electrolytic action.

No Openings Should Be in the Ends

Whatever the type of tank, it is best to have no openings in the ends, sides or bottom. This is, of course, to prevent leakage; in addition, they are not necessary. All openings should be in the top. Certain horizontal steel tanks, however, may be fitted underneath with a plugged drain for clean-out and flushing purposes, although this is not essential. In tanks where a horizontal heating coil is used, as shown in Fig. 2, care must be taken in making up the flanged joints in the tank shell where the steam-heating pipe enters and leaves.

All openings such as filling pipe, manhole, etc., must be closed tight when not in use. The outlet of vapor is by means of the vent pipe, which should always be fitted with a return bend or gooseneck, to prevent chance sparks or flaming material from dropping into the tank. The open end of the gooseneck must be covered with a non-corroding wire mesh to keep flames from traveling back into the tank should the vapors become ignited.

An emergency steam line should be run to a fuel-oil tank wherever possible. It serves two purposes—for

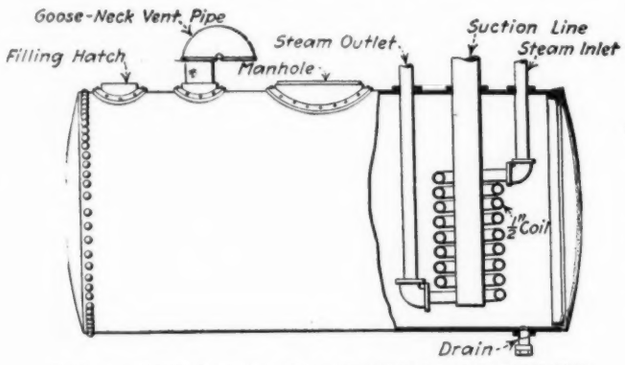


FIG. 1. STEAM COIL FOR HEATING SUCTION PIPE

fire protection, by means of steam smothering, and for clearing the tank of vapors prior to repair or cleaning, by means of steaming out.

Any oil-storage tank should be so located as to avoid exposing near-by buildings to unnecessary fire hazard. Underground tanks should be set with their tops at least three feet below the ground surface. A tank should not be so set as to be in danger of being submerged by possible floods, high tides, etc. If such are prevalent in the particular locality, the tank site should be surrounded by a suitable dike or levee, of earth, concrete or brick. There should be no cut in any dike, and steps should be installed for crossing at any place. Do not climb or walk unnecessarily on an earthen dike. It will soon become worn down and of little service for its purpose.

Finally, consult the rules and requirements for the storage and use of fuel oil, as laid down by the National Board of Fire Underwriters, before any plans are made to build or locate storage tanks.

The number and size of tanks required will depend on the facilities for delivery of the oil, the distance

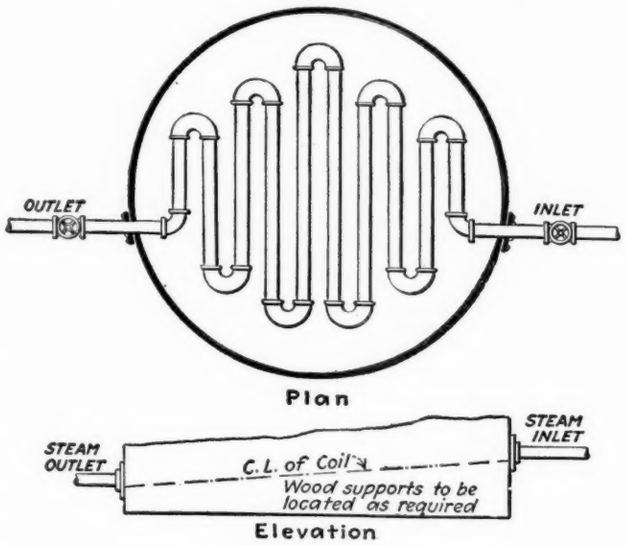


FIG. 2. HORIZONTAL TYPE OF PIPE COIL

of the plant from railroad or dock, the method of delivery of the oil (by tank car, wagon or boat), the time required for transportation and delivery, the daily consumption of the plant, and weather conditions which might hold up deliveries. In general the main tank or tanks should have a reserve capacity of at least one month's oil supply.

Another point in favor of ample storage facilities is the fact that a large part of the water and sediment in fuel oil can be removed by settling.

The term prepared fuel has meant to the trade the sizing of fuel. This has resulted in considerable benefit as different classes of plants are able to operate better on one size of coal than on another. Washing, a common method for preparing fuel, has reduced considerably the ash content. The volatile constituent of coal is of greater value in other ways than as a fuel and efforts have been made to separate and utilize this volatile more efficiently. The volatile matter in coal contains a wide range of hydrocarbon compounds of a resinous character, capable of being split up into many different substances. The hydrocarbons have been digested with phenol, and other solvents, such as selenium oxide, have been proposed for the same purpose. Obviously, any method of preparing coal must result in such improvement in fuel utilization as to cover the cost of preparation. Roughly, a ton of coal produces 30 to 40 gal. of oil, the value of which will depend on how far the splitting up and manufacturing process is carried, but which it is hoped will more than equal the original cost of the coal. There are plans for coal treatment based on subjecting the volatile matter to an atmosphere of hydrogen and thus saturating more of the unstable compounds for the purpose of increasing the yield of byproducts.

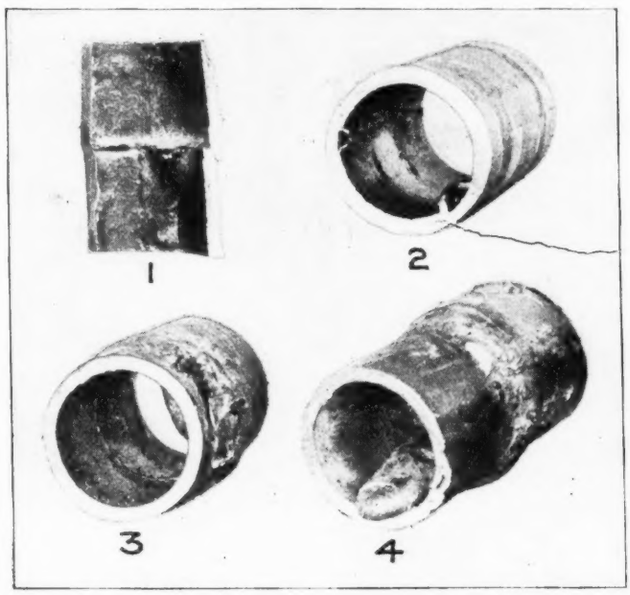
An Unusual Case of Thermit Pipe Welding

By EDWARD A. MILLER*

RECENTLY, a user of Thermit pipe welding for refrigerating purposes reported that the Thermit burned holes through the pipe, notwithstanding that correct molds and portions were employed; that the trouble did not occur at every joint that was attempted, but in a large percentage of the welds. Investigation disclosed that wrought-iron pipe was being welded, the term "wrought-iron" being used in its literal sense (that is, the pipe was actually made of wrought iron and not of steel) and that the size was 1¼-in. standard.

It is well known that wrought iron is not as homogeneous as steel and is subject to oxide inclusions. These result in a laminated structure, chiefly microscopic, but in some cases macroscopic (visible to the naked eye) as well. The microscopic structure would be no impediment to welding, nor would the macroscopic ordinarily be, and consequently the cause of the trouble had to be sought further. It was finally found to be due to the laminations in the iron being so large and extensive that when the skelp from which the pipe was made was bent into tubular form, the inside wall of the pipe (in some places where considerable area of lamination existed) actually wrinkled, forming blisters of metal. Some of these blisters were as much as an inch long, one-half inch wide and perhaps one-quarter inch high, and involved half the thickness of the wall of the pipe, more or less.

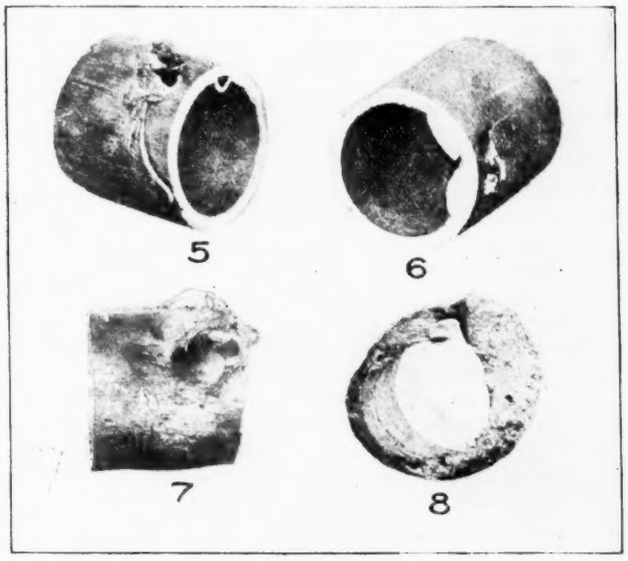
The pipe in question (1¼-in.) is one of the smaller sizes which are butt-welded, and the batch of pipe in



FIGS. 1 TO 4. SECTIONS OF BLISTERED PIPE, WELDED

which the trouble occurred was probably welded without a mandrel or "ball," for the latter would have flattened out the blisters after they had formed, although it might not have obviated the subsequent trouble. Besides this, there is reason for supposing that the lot of iron from which the skelp (and, in turn, the pipe) was made was of poor quality or that the metal had been overheated at some stage in the manufacture of the pipe.

In welding this defective pipe, if one of these blisters happened to be at the point where the two pieces of



FIGS. 5 TO 8. SECTIONS OF BLISTERED PIPE, WELDED

pipe were to be joined, or near it (so as to be in the zone of highest temperature), the same action took place locally at the area of the blister as would take place in the case of a thin pipe inadvertently welded in a mold and with a Thermit portion too large for it. The thin portion of the wall of the pipe covering the blister became overheated and melted; whereupon the same action was repeated when the Thermit struck the blister on the inside of the pipe. Finally, the pipe was completely punctured, and the Thermit ran into the bore of the pipe.

The trouble was overcome by carefully examining the pipe ends about to be prepared for welding, and if any blisters were seen within half a mold length of the pipe end, enough of the pipe was sacrificed to have at least half a mold length of unblistered pipe on each side of the joint.

For the benefit of the casual reader it may not be amiss to reiterate the difference between Thermit welding, as the term is ordinarily understood, and the special application of Thermit as employed in the butt-welding of pipe, tubing and sometimes of solid rods.

In the usual welding procedure the parts to be joined are slightly separated and are placed within a sand mold which is somewhat chambered out around the ends to be welded together. The inside of the mold and the metal ends projecting into it are preheated to a red heat, and finally Thermit steel is run into the mold, fusing into the adjacent parts and effectually forming one continuous piece of metal with them. In this case the steel is tapped from the bottom of a crucible in which the reaction has just been performed. Thus the steel enters the mold first and fills it before the

*Assistant superintendent, Metal and Thermit Corporation, New York City.

molten slag (oxide of aluminum, or alumina) can enter. In welding pipe by means of Thermit the ends of the pipe are carefully faced and closely butted together (instead of being separated) and are held in that position by means of suitable clamps. Instead of ramming sand around the pipe for each weld, a cast-iron mold is employed, forming a chamber around the pipe similar to that formed in sand. The mold is in two parts and can be used repeatedly. The crucible in which the Thermit is reacted for this operation has no tap hole at the bottom, but its contents are poured out over its edge. In this case the slag (being lighter and lying on top of the steel) enters the mold first, coating the inside of it and the outer wall of the pipe. The first impact of the slag against the cold metal renders it sufficiently viscid to form an adherent coating on the metal. This coating prevents the Thermit steel, which later enters the mold, from coming in direct contact with the metal and alloying with it; and consequently, the steel does not melt into the metal but is solely employed as a source of heat. In this procedure there is no preheating.

Slag Is Useful as a Heating Agent

The size of the pipe mold, the capacity of its chambers, and consequently, the amount of Thermit necessary to produce sufficient steel and slag to fill the mold have been carefully determined for each diameter of pipe and for each thickness of wall for any diameter. In passing it might be emphasized that in pipe welding both the steel and slag are employed, as the slag is also useful as a heating agent. In ordinary welding practice enough Thermit is used to fill the mold with steel, the slag filling a basin on top of the mold so that it (the slag) shall *not* come in contact with the parts to be joined and form the protective coating just referred to, as this would impede or wholly prevent the parts from fusing together.

In pipe welding, the Thermit steel and slag, as said before, are used simply as a heating agent. Shortly after the molten mass has been poured into the mold, the ends of the pipe will be sufficiently hot and plastic enough to be butt-welded together by drawing up on the nuts of the draw-bolts, which are part of the clamps in which the pipe was assembled in the first place.

In following what happens after the molten mass has been poured out of the crucible, it is evident that there is a transference of heat from the molten mass to the pipe and to the mold and an escape of heat through the walls of the mold into the atmosphere, and a much smaller escape of heat through the bore of the pipe. This will continue until there is an equalization of temperature, after which the entire assembly will cool together.

Determining Quantity of Thermit

The point that is observed, therefore, in determining the quantity of Thermit is to have this quantity fulfill the following conditions: When equalization of temperature has been reached and before the subsequent cooling sets in, this temperature should be such that the pipe is sufficiently plastic to weld perfectly, but not so hot as to involve any danger of its collapsing or of the Thermit steel melting through the protective coating of viscid slag and melt through the pipe or (as a secondary consideration) to injure the mold.

It can readily be seen, therefore, that if two pieces of pipe of the same outside diameter were taken, one having much heavier walls than the other, and the lighter pipe were to be welded, using the mold and amount of Thermit intended for the heavier one, the Thermit steel would melt through the walls and run into the bore of the pipe before equalization of temperature set in. This fusion might result either from radiation of heat through the protective coating of viscid slag, or by actual contact of the pipe with the molten steel, the excessive quantity of the latter being sufficient to render the slag coating fluid again and wash it away.

In the special case under discussion the thin portions of pipe wall resulting from the blisters were analogous to too thin a pipe, although the thin spots were favored by conduction of heat from them to the adjacent thicker portion. This would not account for every blister resulting in a hole. Fig. 1 is a case in point; the illustration shows a segment of pipe cut out and extending on both sides of the weld. Here there was a half-blister at the very line of the weld but it did *not* melt through. Fig. 2 is a piece of pipe that was not welded, showing a blister. Figs. 3 and 4 show pieces of pipe, each with a hole melted through *at* the weld, the latter plainly showing the Thermit steel that had run into the bore of the pipe. Figs. 5 and 6 show pieces of pipe, each with a hole melted through *away* from the weld; Fig. 6 also shows steel that had run into the pipe. Fig. 7 shows a piece of pipe where the molten portion had congealed without separating from the wall of the pipe; but remaining standing away from the latter. Finally, Fig. 8 shows an extreme case where the pipe had been melted completely asunder.

Redmond Tilting Steam Trap

The illustrations show a two-chamber tilting type of steam trap recently patented by John Redmond, 377 East 158th St., New York City. This trap is automatic in action and will handle high-temperature water, de-

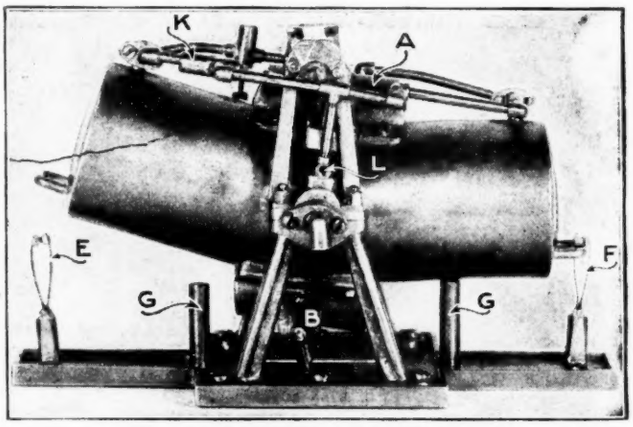


FIG. 1. SIDE VIEW OF TILTING TRAP

livering it directly to the boiler or other receptacle regardless of the pressure or temperature in the vessel. The machine receives and discharges at the same time and can be made to act as a jet condenser by a partial vacuum produced as the makeup feed water for the boiler is passed through it.

This machine can also be employed to handle oil or other liquids by using compressed air instead of steam. It also serves as a water meter, as by attaching a counter to the machine it will register the cubic feet

of water passing through it, as it cannot reverse from one filling position to another until the receiving tank is filled. The machine is made both horizontal and vertical, as shown in Figs. 1, 2 and 4. The two chambers of the trap are formed by a partition through the center, at which point it is also pivoted, as shown in Fig. 1, so as to tilt first one way and then the other.

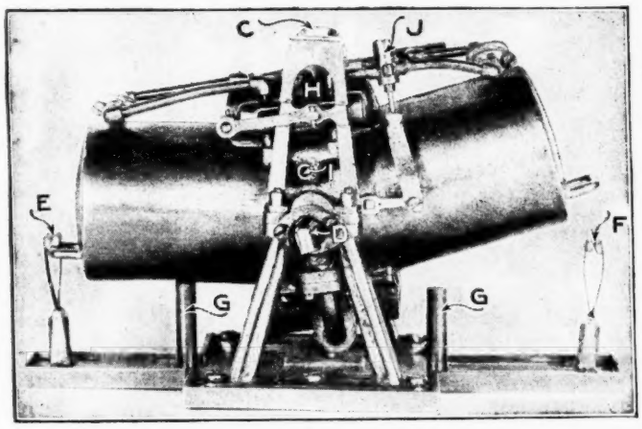


FIG. 2. VIEW OF OPPOSITE SIDE OF TRAP

Suitable valves for controlling the incoming steam and water and the discharge of the water are also provided. The condensate enters either one of the chambers through one trunnion and is discharged through the opposite one. Steam for discharging the condensate enters through a pipe attached to the cylinder, the admission and discharge being controlled by two double piston-type valves located in a chamber on the top and bottom of the trap body, as shown at *A* and *B*, respectively, the valves being actuated by an arm working in the slot *C*, Fig. 2. As the filled end of the trap tilts to the discharge position, the valve is moved to uncover a port connecting with the end of the cylinder, and the admission of steam forces the contents out through the discharge pipe *D*. In the meantime, the other end of the trap is filling, and upon receiving its proper amount of water, the trap tilts to the opposite position, which reverses the movement of the inlet and discharge valves and the water is discharged from that end of the trap. The volume of water admitted to the trap is regulated by the tension of springs *E* and *F*, which are adjusted by thumbscrews, not shown. A stop limits the travel of the trap on the tilt.

Steam for discharging the water from the trap is admitted to the double piston valve *H*, Fig. 2, through the inlet connection *I*. The valve chamber of *H* is piped to each water chamber of the trap, each pipe connecting to a piston valve *J*. The stem of this valve is through a suitable lever and link, connected to a float, Fig. 3, arranged in each tank chamber. As the end of the tank fills, the water lifts the float and opens the inlet valve *J* to that end of the trap ready to subject the contents to boiler pressure. When that end of the trap tilts sufficiently to overcome the tension of the spring *G*, its weight tilts the trap to the discharging position and simultaneously closes the inlet valve *A* on that end, and then the vent valve *K*, Fig. 1, and opens the discharge valve *D* and steam valve *H*, Fig. 2. When the other end of the trap is ready to discharge, a similar action takes place through a duplicate set of valves, not shown. The vent valve *K* is opened while its end of the trap is filling. Thus the trap will continue to operate automatically as long as condensate and steam pressure are admitted to the chambers. The connection *L* is to take care of the vapor and air when venting the trap chambers. Fig. 3 is a section through the trap body, showing the float and the admission and discharge water valves.

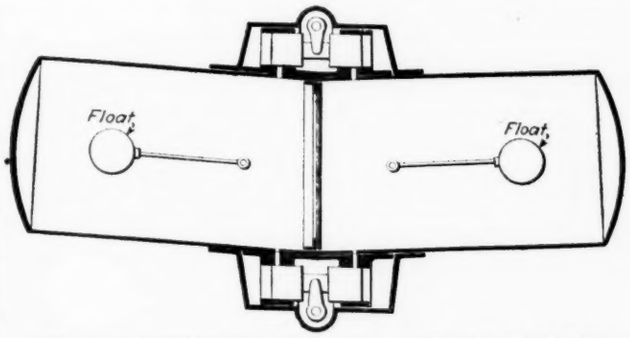


FIG. 3. SECTION THROUGH TRAP AND MAIN VALVES

The device shown in Fig. 4 is also a steam trap, but in addition it can be used as a water weigher and as a sewage discharger. The latter is possible because there are no valves to become clogged, the inlet and outlet being through a round opening in a tube that is moved to cover and uncover openings in the discharge cylinder

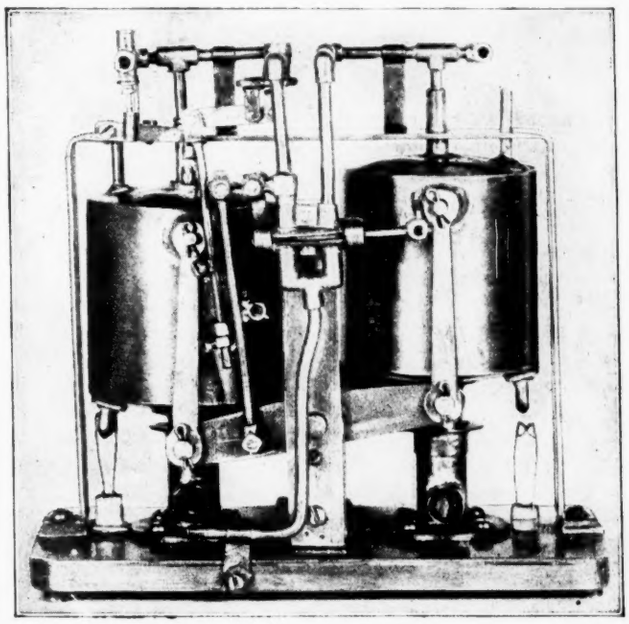


FIG. 4. TRAP CAN BE USED AS A WATER METER AND FOR SEWAGE DISPOSAL

shown between the water cylinder and the base. Thus the sewage has free passage to and from the two cylinders. The method of operating is similar to the trap shown in Figs. 1 and 2. The halftone illustrations were made from photographs of models.

The Alloys Research Association, which is being formed now, is organizing an Alloys Informational Service for two purposes—to supply information as to new results and to look up existing data, for those interested in metals and their alloys The Research Extension Division of the National Research Council, Washington, D. C., is aiding and will be glad to answer inquries

Economical Generation of Electrical Power*

BY A. B. CLARK
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IN ORDER that the treatment of the problem might not be too general, the design and operation of a steel-mill plant carrying about 15,000-kw. average load and with peaks running up to 25,000 kw., is considered. The first two points to be given attention are the facilities for water and coal supply. In the power plant the water will be chiefly needed for condensing purposes, and it should be quite possible, if water is scarce, to pass the condensing cooling water into the service system. It would be hotter by about 10 to 15 deg. F. than if pumped direct from the source of supply, but this might be an advantage, particularly during the winter months.

Plans should be based on burning the kind of coal obtainable to the best advantage, and there are by-products such as coke braize and blast-furnace gas which should be used when available for making steam in the power plant. In judging the economical value of a coal, it should be tested by being burned under a boiler and the cost of making 1,000 lb. of steam determined. This is the only proper way, as an analysis may show high heat value, low ash, etc., and still the coal may not behave properly in a boiler furnace. Knowing the nature of the load, it remains to discuss the size of the units. Generally, the larger the unit, the more economical. To begin with, assume that two units are to carry the maximum load, running up to 25,000 kw. In this case the capacity of the units would be 12,500 kw. each, which happens to be a commercial size. As the average load is 15,000 kw., each will carry 7,500 kw., or about 60 per cent of the maximum load. From a steam consumption point of view the most economical load is about 70 to 75 per cent of the maximum load, so it is evident that the two units would be working not quite on their most economical point, but the nature of the load will not allow this. If the plant is not tied in electrically with any other, a spare unit should be installed, making three turbo-generators of 12,500 kw. each, or 37,500 kw. in all.

Points to be considered in the design and operation of a turbo-generator steel-mill plant carrying an average load of 15,000 kw. and peaks up to 25,000 kw. Facilities for water and coal, size of units, types of condenser and auxiliaries, kind and size of stokers, use of economizers, coal and ash handling, instruments used and importance of educating the fireman.

Now suppose the load to be carried by one unit. It must have a capacity of 25,000 kw., and a spare unit would require the installation of 50,000 kw. On the other hand, suppose the load to be carried by three units. Then each would be loaded to 8,300 kw. and the nearest commercial size would be 7,500 kw. If the 25,000-kw. peaks were of short duration and the steam pressure well up, perhaps the best thing to do would be to have the turbines designed for 200 lb. steam pressure at the throttle. Then if the steam pressure were raised to 225 lb., a 7,500-kw. unit would carry 8,300 kw., as the load carried is directly proportional to the absolute pressure of the steam. At normal load each would carry 5,000 kw., or 66 per cent of its maximum load and therefore somewhat nearer the most economical point for the unit. With one spare unit this means four 7,500-kw. machines, or 30,000 kw. in all. There is, therefore, a choice of two 25,000-kw. units aggregating 50,000 kw., three 12,500-kw. units totaling 37,500 kw. or four 7,500-kw. units giving an installed capacity of 30,000 kilowatts.

Now the cost per kilowatt is rather less the larger the unit, and this applies to the floor space covered, piping, auxiliaries, etc. Also, in nearly all plants the demand for power increases and consequently larger units will be used in extensions. From all points of view the three 12,500-kw. units appear to be the best for the conditions. Two will run on the load, the question of a spare depending on whether the plant is tied in electrically with any other plant that can supply the demand if one unit breaks down. In a plant of this kind the steam pressure and superheat should be as high as standard piping, valves and fittings will allow, which is about 250 lb. and superheat of 250 deg. With these standards 250 lb. will be the maximum pressure in the boiler drum when all safety valves are blowing and relieving the boiler of the maximum weight of steam. The average steam pressure will be less, as allowances must be made for pressure drops through piping, valves, etc., bringing down the steam pressure at the turbine throttle to about 200 lb. and the superheat to about 200 deg. F. The distribution of steam pressure will be about as follows: Normal working pressure in boiler drum, 230 lb. gage; pressure after passing superheater at boiler outlet, 220 lb. gage; pressure at turbine header, 210 lb. gage. Thus if the turbine is designed for 200 lb. pressure, there is a little leeway and it will carry easily its maximum load.

Amount of Condenser Surface

Surface condensers should always be used unless the cooling water is particularly good for boiler feed, which is not often the case.

The amount of surface is usually based on condensing about 7 lb. of steam per square foot of surface per hour, or about 1.6 sq.ft. of surface per kilowatt of rating, amounting to 20,000 sq.ft. for a 12,500-kw. machine. A turbine such as is being considered will generate a kilowatt-hour on about 11.25 lb. of steam, or 140,600 lb. of steam per hour, which reduces to approximately 7 lb. per sq.ft. of condenser surface. To condense 1 lb. of steam in the condenser requires the extraction of about 950 B.t.u. per pound of steam. If the rise in temperature of the cooling water passing through the condenser is 15 deg. F., the quantity of

*Abstract from a paper read before the Chicago Section of the Association of Iron and Steel Electrical Engineers.

water required will be about 18,000 gal. per min. Two units will therefore require 36,000 gal. per min., which, if clean enough, could be pumped into the service water lines or, if not, thrown away. With this quantity of condensing water a vacuum of 29 in., or 1 in. absolute, will be obtained with inlet water at 50 deg. F. and the condenser reasonably clean. Better results are possible with the condenser in good condition.

Condenser Auxiliaries

The condensing water will be pumped by a centrifugal pump, and if the discharge pipe from the condenser is carried below the water level, the head against the pump will be about 15 to 16 ft. As the pumps in ordinary commercial service will not average much over 50 per cent efficiency, a 150-hp. motor will be required, but it is good practice to use a large motor, say 200-hp., especially if the motor is located in a warm place.

Slow-speed pumps are as a rule more efficient than high speed for this service. Speeds of 200 to 300 r.p.m. are about right if steam drive is required. This calls for a reduction gear, adding another piece of apparatus to the equipment, which gives very little trouble if properly designed and operated.

To remove the condensate from the condenser, a centrifugal pump is now universally used, and, if correctly vented back to the condenser, should give no trouble. To remove the air, it is fashionable at the present time to use a type of hydraulic vacuum pump that operates by trapping air between sheets of water and so carrying it out to atmosphere against the vacuum. All these pumps give a good vacuum if the air leakage is normal, say 5 to 10 cu.ft. of free air per minute. The only drawback with pumps of this nature is that they take a lot of power. On a large unit the percentage of the total is not large, say 100 hp. for a 30,000-kw. machine, but for a 5,000-kw. unit the ratio grows to greater proportions. From the point of view of power consumed, the old Edwards form of air pump takes about as little as any and has the advantage that the higher the vacuum the less the amount of power required.

Boiler Capacity and Size

Under the conditions noted turbines will consume on the average about 12 lb. of steam per kilowatt-hour at full load and the auxiliaries will increase this to 13.2 lb., or by 10 per cent. By auxiliaries is meant the turbine auxiliaries and the boiler-feed pumps, but not compressors or blower engines. At this steam rate 25,000 kw. will require, in round numbers, 330,000 lb. per hour. At the average load of 15,000 kw. the weight of steam necessary is about 200,000 lb. per hour. Steam will be required for other purposes, say for two turbine blowers for blast furnaces, taking 40,000 lb. per hour each. This will make an average demand of 280,000 lb. per hour and a maximum of 410,000 lb. Normal rating on a boiler calls for an evaporation of about 3 lb. per hour per square foot of heating surface, but boilers are usually worked at rates of two to three times this. As large demands for steam will be made suddenly, assume that the boilers will be worked at 200 per cent of their normal rating on the average demand. This means 6 lb. of water evaporated per square foot of heating surface per hour, or a total surface of 46,700 sq.ft., divided into, say, four boilers of 12,000 ft. each, or five boilers of 10,000 sq.ft. each, or six boilers of 8,900 sq.ft. each.

If using the large boilers, when one is down for repairs or cleaning, the remaining three will each have to evaporate 93,300 lb. per hour, operating at 260 per cent of rating. This in itself is all right, but at the maximum demand each boiler will have to deliver 137,000 lb. of steam per hour, or 380 per cent of rating. This is rather high, but can be done provided the feed water for the boiler is good and the water in the boiler not so concentrated as to foam.

By using the 10,000-sq.ft. boilers, if one is down, the four remaining ones will be worked at 233 per cent of rating at the average condition and 342 per cent at the maximum. This is much better. If the same analysis is made with the 8,000-sq.ft. boilers, it will be found that no material benefit is obtained. Consequently five boilers of 10,000 sq.ft. of heating surface each will be used.

To give the required superheat, about 3,000 sq.ft. of heating surface will be required in each boiler, the amount depending on the design of the superheater and its location.

What has been said previously refers to coal-fired boilers. Should blast-furnace gas be available, some of the boilers might be fitted to burn this fuel. As it is a poor gas, averaging about 90 B.t.u. per cubic foot, or 1,100 B.t.u. per lb., maximum ratings of from 150 to 200 per cent are all that can be expected. If the fuel were entirely blast-furnace gas, seven or eight boilers and 80,000 cu.ft. of gas per min. or more would be required.

Type and Size of Stoker

All types of stokers have their particular field of usefulness depending upon the service required and the fuel available. If any coke braize is handy, this must be burned, and to change from coal to coke braize, and vice versa, should be done with a minimum of adjustment. Stokers of the forced-draft type are considered necessary to meet the conditions, and those which vary the air pressure under portions of the grate are the most scientific, as it is possible to deliver the air where it is needed. Generally speaking, fuel should be burned quickly with moderately thin fires, particularly if a fuel has a tendency to coke. The stokers should remove the refuse quickly and so prevent the forming of large clinkers, which are difficult to remove and make dirty fires. Stokers of the traveling-grate type should be run at speeds of 6 to 7 in. per min. and fuel beds should be 6 to 7 in. deep.

The grate area should be figured on the basis of burning about 70 lb. of coal per square foot per hour as a maximum. If the efficiency is assumed to be 75 per cent, then on the maximum condition of 102,500 lb. of water evaporated per boiler per hour, 16,000 lb. of coal of 10,000 B.t.u. per lb. will be consumed. At 70 lb. per sq.ft. of grate, 230 sq.ft. of active grate area will be required.

Use of Economizers

Under the conditions stated the flue gas temperature at the boiler uptake will be about 600 deg. F. and will therefore contain considerable heat. If the plant has a high load factor, it would pay to install economizers. Before deciding, the interest on the investment, repairs, etc., should be balanced against the saving expected. An economizer having about 50 per cent of the boiler-heating surface will save about 10 per cent on the fuel and reduce the stack temperature from 600 deg. F. to about 300 deg. F.

If economizers are not installed, the necessary draft can be obtained from a stack about 200 ft. above the grate, but with economizers the additional draft required would call for a stack of exceptional height and cost. It would be better to install an induced draft fan and a stack just high enough to take the gases away from the roof.

Coal Crushing and Handling

It is important that the coal be of the right size, 1¼ in. screenings being a good average. If screenings are not available, the coal must be crushed to the right size and all should pass through a 1-in. ring. Generally insufficient thought is given to this part of the equipment of a power plant. As much as 5 per cent may be lost in the efficiency of a boiler plant from irregular sizing of the fuel. After being crushed the coal should be screened, so that only coal of the correct size can be taken up to the bunkers. The coal that does not pass the screen should be recrushed. The coal crushing or preparation plant should be placed outside of the power house building and not put in some corner of it as if it was an afterthought.

For handling coal in any large quantity the proper way to unload it from cars is to turn the car upside down by means of one of the car unloaders that are now on the market. Dump cars will not always dump and the gates require adjustment, which takes time and labor. For unloading relatively small quantities of coal a grab-bucket crane is quite successful. A 2-yd. bucket is about as large as can be used conveniently in a car.

For conveying the coal, bucket and belt conveyors are used. Bucket conveyors should not run much over 50 ft. per min. and the slower the better. Belt conveyors of canvas and rubber may be run up to speeds of 400 ft. per min., from 200 to 300 ft. per min. being a good average. In Europe steel belts are finding a place and for some materials are reported to be very successful.

To handle ashes there is only one way that really is good practice, and that is to empty the ashpits directly into a car. The operation is positive, complete and cheap, and it is worth while to go to some expense to arrange the plant so that this can be done.

Firemen and Proper Instruments

It may be said that the most important man in a power plant is the fireman. He handles large quantities of an expensive raw material and has a splendid opportunity to waste as much as he likes. The boiler may be supplied with all kinds of instruments, but they represent money thrown away unless the fireman can understand them. Given a high-class fireman, then the more instruments he has the better. These should consist of a flow meter and draft gages for indicating the draft at any point that will tell anything. It is impossible to work any of the modern type of forced draft stokers without them. All instruments should be indicating, as they are for the use of the firemen and not to fill a filing cabinet with records.

All control stations for fan speeds or stoker motors should be so placed that the fireman can make the necessary adjustments while he is looking at the instruments. CO_2 machines are useful, but do not tell the whole story, as a man can get easily a high CO_2 and still be wasting coal.

A useful instrument is a flow meter of the indicating type so that the fireman can see which boilers are carrying the load and whether he is working too many boilers, or vice versa. Of course, there are many other instruments that are useful, but a really good fireman can get all there is out of a boiler by the intelligent use of draft gages and flow meters and by observing the fire.

Every boiler should be checked up regularly by means of test instruments to locate and correct defects. The thing to look for is air leakage into the boiler setting. It is not unusual to raise the efficiency of a boiler 5 per cent by reducing the air leakage even in plants which were considered to be run economically. To get good results there are two main points to observe—train the fireman and keep the boilers in good condition.

Electric Versus Steam Driven Auxiliaries

As to the economy of driving the auxiliaries by means of small turbines or by electric motors, there is very little to choose. The electrical drive requires less steam per horsepower-hour, but when the exhaust steam from the auxiliary turbine is used in the feed-water heater, then the actual quantity of heat used may slightly favor the turbine.

To find out exactly what choice to make, the investment must be taken into account and should be worked out for each case. Generally speaking, there is not much difference in economy, but there are other points in favor of electrical drive. For driving pumps, motors are ideal, as practically no attention is required and on alternating-current circuits the speed is nearly constant, so there is no chance of a machine running away on varying loads. The governing of small turbines on varying loads often leaves much to be desired. For starting up, with no electrical power available, steam-driven auxiliaries are essential. It is sometimes advantageous to make some of the auxiliaries steam-driven and some electrical. In this way the heat balance of the station can be adjusted to give the most economical conditions.

Generally speaking, turbine-driven auxiliaries are smaller, owing to their higher speed. Turbine speeds will run about 2,500 r.p.m. or higher, but the motor speeds most in use are 1,800 and 1,200 r.p.m. A two-pole 60-cycle motor will run at 3,600 r.p.m., but pumps do not seem to be developed at this time for so high a speed.

It is sometimes thought difficult to determine just how much steam is consumed by small auxiliary turbines. The following simple method is based on the fact that when supplied with superheated steam (this is practically always the case at the present day) the exhaust steam is also highly superheated. It remains only to obtain the steam pressures and temperatures at the turbine throttle and exhaust, refer to the steam tables and from them find out how much heat the steam contained before and after the turbine. The difference in total heat represents the heat turned into work in the turbine and that lost by radiation, the latter being so small that it may be neglected altogether, or an allowance of 1 per cent made. The difference in heat content as found from the steam tables divided into the 2,545 B.t.u. in a horsepower-hour, gives the weight of steam per brake horsepower-hour. The pressures and temperatures should be taken as near the turbine as possible to prevent excessive radiation losses. If really accurate results are required, the turbine should be lagged.

EDITORIALS

When Should We Buy Coal?

THE year 1919 laid the foundation for the coal shortage of 1920. The question is now whether 1921 is laying an equally secure foundation for coal shortage in 1922. From a production of twelve and thirteen million tons per week in December, there has been a rapid dropping of coal-mine output, falling below ten million in the week of January 15, to 9,200,000 tons for the week of January 22 and to eight million tons for the week ended February 5. The latest figures available point to still further decreases during the succeeding weeks, and the question naturally arises, Where is this tremendous slump in production going to end?

It matters not how the coal situation is handled, in the last analysis the consumer pays for all errors of judgment and faulty proceedings. Therefore it is of vital concern to the coal user to know whether in the long run purchase of coal today will be advantageous or whether he should wait six weeks or two months longer before beginning to buy.

Any large coal user who has opportunity to make a favorable contract for fuel at the present time and who has either money or credit permitting him to do so, will do well to take action to this end at once. Forty-three per cent of the operating time of mines was lost on account of "no market" during the week of January 29. The figures for the succeeding weeks were undoubtedly higher, corresponding to the lower production. This means that coal producers are very approachable just now and that coal users whose stocks are not abnormally high—and few stocks are in that condition today—can build them up to such a point most advantageously. If the coming coal year, beginning April 1, should open with low stocks and a threatened railway strike, the power-plant engineer will again be harrassed by excessive fuel costs. He might even find the mild winter and low production of these recent weeks was building for 1921 a repetition of the coal shortage of last year.

In any such fuel situation coal-car capacity is an important factor. If at all times in every year the railroads could guarantee car supply equal to a *reasonable* peak of demand, there would be no serious difficulty at any season. It is the consumer who suffers when the car supply is inadequate. It is important, therefore, that the coal consumer consider how much more it would cost him that adequate car supply could be insured. A simple calculation on this subject is very illuminating.

Suppose that, because of car shortage, coal on the average advances one dollar per ton for a single month in the year. This would not be a phenomenal advance, judged in the light of the past year's experience, but it would cost the consumers of coal roughly forty-five million. If this amount were invested in coal cars at, say, three thousand each, we would have fifteen thousand additional coal cars. Assuming these cars at an average capacity of seventy tons and that their average round trip was two and one-half weeks, this would provide for nearly half a million tons per week additional production, an amount probably sufficient to eliminate any likelihood of material shortages. In other words, the price that the consumers are likely to have to pay almost any month, owing to temporary shortage of fuel, would provide an investment good for a number of years sufficient to prevent shortages.

It is difficult to figure out just how the consumers are going to arrange for this additional coal-car investment directly. They can indirectly, however, do the same thing if by storage of coal and buying at periods when "no market" is a serious cause of low production, they reduce the demand for car supply at periods of peak demand. A little extra investment in coal stocks, a little more foresight in purchase at times of low demand generally, will thus become even cheaper insurance than additional coal cars would be.

Inspection and Care of Electric Motors

A GREAT deal has been said about continuity of service with regard to the power supply from large power systems or industrial power plants and in many cases considerable expense has been incurred to insure against serious interruption of the supply. However, this is only half of the problem of keeping electric-motor driven equipment in operation, since it does not make any difference how continuous the power supply may be, unless the motors and controllers are maintained in a high state of upkeep, the continuity of the motor operation will be frequently interrupted. Unless given proper attention, the best equipment will fail to give satisfactory service.

A period has been reached when it is recognized that the keeping of records is an essential part of efficient power-plant operation. The records cover not only the cost of producing power, but also inspection, maintenance and service of the equipment. Such records are considered of such importance at this time that a plant that does not keep them is looked upon as a relic of the dark ages in plant operation. We are fast approaching the time when keeping records of electric-motor operation will also be considered a necessary part of efficient motor service. Many plants have developed elaborate record systems for industrial-motor operation; the completeness of such systems was shown in an article, "Motor Records in Industrial Plants," by Philip Chapin Jones, in the issue of February eighth. A large number of plants are developing systems of motor records.

There is ample demonstration that the periodic inspection of electrical equipment pays. Not only is it a means of detecting defects before they reach a point where breakdowns occur, but in the remedying of the defects before they cause a shutdown of the motor, expensive losses in production are avoided. The latter is generally by far the most expensive item in every industrial-motor failure. Not infrequently the cost of repairs is only a mere trifle compared with the loss of production.

In this issue H. M. Phillips in his article, "Inspection and Care of Electric Motors," gives forms for making inspection reports. Form B is of particular interest since not only does it itemize the different parts to be given consideration in making an inspection, but a fairly intelligent report can be made by checkmarking the different factors given on the form that apply to the motor's conditions. Where these reports are made by men who lack the ability to put their thoughts into writing or where new inspectors are employed, this form will be a guide to the parts requiring attention, in the motor and controlling equipment.

Air in Boiler-Feed Water

THE chief engineer of a northern central station recently remarked that it was not difficult to remove air from his condensers with his air-pump equipment after the air got inside, but that it was much more difficult to prevent the air from getting inside the condensers in the first place. It is well known that the presence of small amounts of air in surface condensers results in partial air pressures, which prevent the attainment of the highest vacuum theoretically possible and also require unnecessary work to be done by the air pumps in maintaining vacuum. As the amount of air entering the condenser is diminished, the absolute pressure decreases. With modern turbines a decrease in absolute exhaust pressure results in lowered steam consumption and improved plant economy.

Where does this air come from? Leaks through joints, glands, etcetera, can be cared for by proper machine work and assembly and by the use of paints. This is a problem that offers no serious difficulties to the power-house operating forces. The air that enters with the feed water, however, is more difficult to stop. This matter has only recently received much attention, but interesting progress has already been made to prevent the entrance of air to the condenser through the feed water and boilers.

The condensate removed by a condensate pump contains relatively little air, but is in a state where the water will readily absorb air if given any opportunity to do so. It is therefore necessary to avoid giving this condensed steam any chance to come in contact with air. It should enter storage tanks and heaters only in submerged outlets. Flow through pipes over the edge of tanks allows air bubbles to be carried down with the water and permits absorption of air. Funnels and certain weir devices also allow a mixing of air and water with consequent absorption of air. The discharge from steam-jet air pumps should not be delivered into the condensate tank, as this carries air. Wherever possible, all makeup water should be distilled or made air-free.

In spite of all precautions some air will be taken up by the feed water before it enters the heaters. The greatest possible amount should be removed in these heaters by maintaining temperatures as near two hundred and ten degrees Fahrenheit as possible. J. R. McDermet, in his paper, "The Separation of Dissolved Gases from Water," before the A. S. M. E., last December, outlined a plan for removing practically all the air by heating the feed water in an open heater, then injecting it into a chamber maintained under vacuum and removing the air by boiling action at the expense of some of the heat of the liquid. The feed pump drew its water from this vacuum chamber. Some large central stations use a jet condenser on the house turbine that furnishes power to the plant auxiliaries. The main turbine condensate is the cooling water for this jet condenser. It is claimed that practically all the air is removed from the condensate by the air pump furnished with this jet condenser.

It is apparent that both of these plans will be effective to a degree, but they involve added equipment and increased operating care to secure the desired result. It would seem more logical to devise ways of keeping the air out of the water in the first place by taking certain simple precautionary measures. It is significant that progress is being made in this direction, for one station reports that the air content in the feed water entering the pump from an open heater has been reduced to a relatively low figure when the temperature in the heater is maintained at two hundred and ten degrees.

This air in feed water not only ultimately tends to decrease vacuum in the condenser and thereby decrease plant efficiency, but it causes many difficulties before it reaches the turbine. It is the direct cause of the rapid corrosion of steel feed-water piping. It also makes the use of steel-tube and integral economizers, if not impossible, at least very difficult on account of rapid internal corrosion. Finally, it tends to set up pitting actions in the boiler itself.

Diesel-Engine Survey

IN THE preparation of a survey of an industry the scope of the work is so great that the investigator usually covers only a minor portion of the particular industry. Then, by using some factor he arrives at a result that is taken as representing the entire field. In the survey made of the Diesel-engine industry, the results of which appear in this issue, a radical departure was made from this standardized method. Every Diesel engine manufactured in the United States was covered; location, purchaser and details of service performed by each unit were ascertained. For these reasons the results given in the survey may be well considered as accurately portraying the growth of this industry from the first American Diesel up to January 1, 1921.

The charts showing the growth of the Diesel application in the chief industries are of decided interest. While the yearly growth is by no means consistent, nevertheless the same trend toward a greater employment of the Diesel is shown in all the industries charted. The central-station application is probably the most uniform; this is due to the fairly uniform increase in central-station capacities of all kinds. Attention is likewise called to the tabulation showing the number of Diesels by states and by industrial application. These data reveal that the scope of the Diesel's adaptability is not confined to narrow limits.

The manufacturer of Diesel engines should find much in this survey to cause him to redouble his sales and manufacturing campaigns. During the last few years, production costs in many lines were of little moment, for, as has been fitly observed, it was a seller's market. In the future, with lower selling prices, production costs must be cut to the bone. In many lines the cost of power is a large item, ranging downward from eighty per cent. Because of this, more interest will be displayed in the question of economical production of power. The Diesel possesses a high thermal efficiency and with intelligent supervision has an extremely low maintenance cost. All these are inducements toward the further popularizing of this prime mover.

CORRESPONDENCE

Are Small Boiler Tubes Desirable?

Mr. Riggin, on page 153 of the Jan. 25 issue of *Power*, states that by increasing the number of tubes the water-storage capacity is decreased. If such is the case, I cannot understand how he is decreasing the steam-disengaging capacity or heating surface; nor can I understand how the steam-storage capacity is decreased unless the tubes were located higher in the flue sheets, thereby reducing the upper segment.

I agree with him that small tubes retard circulation. If the tubes are arranged in staggered rows, the arrangement would retard the circulation still more.

As smaller-tube boilers have less water-storage capacity, the explosive volume would not be so great. In using smaller tubes more draft is required and the flues are more likely to become plugged with cinders, ashes, soot, etc. The heat in the gases of combustion is not absorbed as completely as when using larger tubes. Tubes of from 3- to 4-in. have given satisfactory results.

Olean, N. Y. CHARLES W. CARTER, JR

Return-tubular boilers are designed to give free circulation, but the effect of too many tubes is to fill the water space so that the heated particles of water forcing their way upward meet with a great deal of resistance and this cuts down the steaming capacity. Of course extra tubes could be put in above the ones already in, but they would reduce the steam space. If tests were made on boilers with and without these extra tubes, little improvement if any would be shown.

When more heating surface is required for a given size of boiler, the adding of tube surface should be done when building by putting in smaller tubes and more of them. L. B. SHIELDS.

Chicago, Ill.

I have had several years' experience with all classes of boilers in some of the largest power plants, and around small mills and coal mines. I have tried all sizes of tubes from 1½-in. up to 6- and 12-in. flues. I have found for stationary work that the 3- to 4-in. tubes are the most satisfactory as they are easier to clean. Larger sizes are hard to handle, and smaller tubes are harder to keep from leaking. My preference is the 3½-in. tube.

Russellville, Ark. H. M. DUNN.

In reply to N. S. Riggin's inquiry I submit the following:

I sold to a customer in Manila two 72-in. by 16-ft. return-tubular boilers. One had 3-in. tubes and the other 4-in. tubes. On this customer's next trip to the States, I asked him about his boilers and he said the one with 3-in. tubes was the more economical in fuel and was far easier to get up steam in the morning.

I sold a customer in Oakland one 66-in. x 16-ft. boiler with 3½-in. tubes and later a 72-in. x 16-ft. boiler with 3-in. tubes. He was so well satisfied with the smaller tubes that I sold him two more 72-in. boilers with 3-in. tubes for installation at another plant. He claims that the 3-in. tubes give far better service and the cost of fuel is less.

I have heard that one of the oil companies here has changed the size of tubes in one of its plants, as it is believed that small tubes give the best satisfaction. All the boilers I sold were second-hand except one. And they would not accept any boiler other than one with 3-in. tubes. C. L. REA.

San Francisco, Cal.

At the plant where I am employed there are ten new boilers, built with 3-in. tubes, installed during the summer of 1920. They have all the faults Mr. Riggin points out, and we find that more boilers than should be necessary to carry the load are required, or we get slugs of water over with the steam.

Each boiler has two nozzles, one at the front and one at the back. Steam is taken from the front nozzle, which is directly over the fire. This, I think, is poor practice, as it is the hottest point and the rapid boiling carries the water to the nozzle.

I would like to know the experience of *Power* readers who have operated boilers with the steam pipe connected to the back nozzles. J. P. COLTON.

Lima, Ohio.

Oil in the Expansion Coils of the Refrigerating System

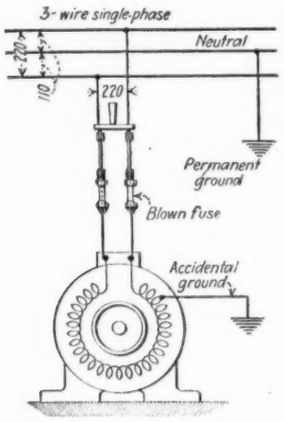
In the Jan. 11, 1921, issue of *Power*, page 71, in his article on "Oil in the Expansion Coils of the Refrigerating System," F. L. Brewer says: "After passing the separators the next place in which the oil would accumulate is in the top of the liquid receiver, for oil is lighter than liquid ammonia."

I have never seen oil in a refrigerating system act that way. In drawing oil from separators the liquid ammonia that may be in them never comes until the oil is all drawn off, also any oil that may come over to the liquid receiver always shows in the bottom of the gage glass. We have the vertical type receiver and use a first-class oil for the ammonia system. I would like to hear from others regarding this matter.

Fresno, Cal. E. C. CUNNINGHAM.

Operation of Single-Phase Motor with Grounded Windings

A motor-driven pump refused to come up to speed upon closing of the automatic pressure switch. The motor was a single-phase, 1-hp., 220-volt repulsion-induction machine, supplied from a three-wire 110-220-volt single-phase line with grounded neutral. When the switch closed it started up, but ran so slowly as to be unable to throw out the centrifugal starting clutch. When the pump belt was removed, however, it rapidly came up to normal speed, but slowed down as before as soon as the belt was put on again.



CONNECTIONS SHOWING OPERATION OF GROUNDED MOTOR

A preliminary investigation showed that one of the fuses was blown and that the motor was apparently running on open circuit. An insulation test on the windings soon explained this. The stator windings were found upon examination to be grounded to the frame of the motor near one terminal, and this had caused a short-circuit between that terminal and the grounded neutral and blown the fuse on that side. This left nearly the total motor windings connected between the other side of the line and the neutral, through the frame of the machine and the ground. It was therefore operating on 110 volts, with a correspondingly weak torque.

E. S. BAXTER.

Boston, Mass.

Data on Motor Operation

I was very much interested in the article, "Data on Motor Operation," by Mr. King, on page 116, *Power*, Jan. 18, especially the first section. It seems to me that the rewinding costs are high even at the minimum of $3.70 per motor, as given. As I take it, the rewinding costs are separate from installation charges and maintenance costs, therefore are excessive, especially so, since all polyphase squirrel-cage induction motors of 1½- to 15-hp. capacity are used.

Conditions are somewhat different on the very small sizes because an increase in friction or an additional load may cause considerable overload; they are not so sturdy and require more attention. In sizes of 50 hp. and up the expense is high when rewinding is necessary.

I have under my direct supervision 314 motors ranging from ½-hp. single-phase 110-volt to ½-hp. and from ¼- to 50-hp. three-phase 440-volts, all 60-cycle machines and in operation. I have one assistant, and we do all installing and maintaining, minor electrical and mechanical repairs. Our rewinding and coil work is done at a factory in town that specializes in armature winding, and for the reason that our rewinding costs are so low it does not pay us to install the necessary equipment to do this work. The rewinding costs for the years 1918, 1919 and 1920 were as follows:

In 1918 one motor rewound, others required new coils; 289 motors in operation; total rewinding cost for the year $102.36; costs per year per motor, 37.5c. In 1919 one motor rewound, others required new coils; 30[illegible] motors in operation; total rewinding cost for the year $102.92; costs per year per motor, 33.7c. One motor rewound and others required new coils in 1920, 31[illegible] motors in operation; total rewinding cost for the year $121.27; costs per motor per year 38.7c. This shows approximately one-tenth of Mr. King's minimum costs of $3.70 per motor.

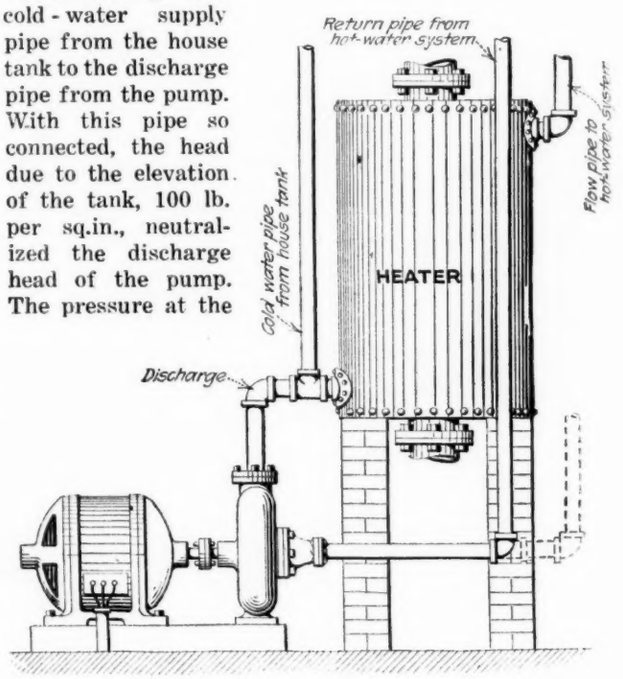
B. S. EMMONS.

Boston, Mass.

Correcting Defective Hot-Water Piping

The hot-water service on the top floor of an office building had been unsatisfactory for a long time. The flow from the faucets on this floor was quite sluggish at all times, but when the tenants on the floors below were drawing considerable quantities of hot water, the supply to the top floor was inadequate.

Apparently, the engineer did not know what to do to remedy the difficulty. The centrifugal circulating pump in the basement was piped as shown in the drawing. The system ran thus for a number of years. Eventually, another engineer took the job. The first time the tenants on the top floor registered a complaint with the new engineer about their hot-water service, he took a look at the piping of the circulating pump and immediately divined the cause of the trouble. It was all due to connecting the cold-water supply pipe from the house tank to the discharge pipe from the pump. With this pipe so connected, the head due to the elevation of the tank, 100 lb. per sq.in., neutralized the discharge head of the pump. The pressure at the lowest elevation of the hot water system was, therefore, only 100 lb. per sq.in., while the pressure at the top floor, when no water was being drawn off on the floors below, was that due only to the few feet difference in level between the faucets on the top floor and the house tank in the garret. The new engineer changed the connection of the house tank from the discharge to the suction side of the pump, as indicated by the dotted lines in the illustration. A tee replacing the elbow shown in the return line, made the change easy. The pump then gave a circulating pressure of 115 lb. per sq.in.



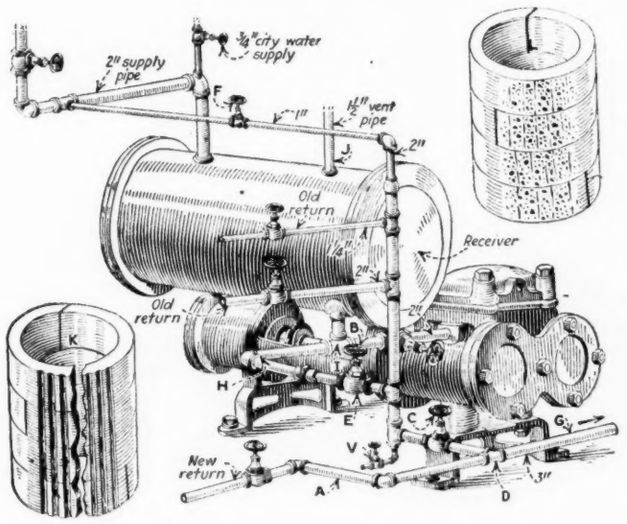
SHOWING CHANGES MADE IN PIPING

St. Louis, Mo.

A. J. DIXON.

Pipe Connections to Receiver and Feed Pump

The following may be of interest to readers of *Power* who may be putting in additions to their present heating systems, more and larger radiators or radiators and pipe lines for a new building. The illustration shows the boiler-feed pump and receiver used on a gravity-return heating system. The plant recently had a new building added and a vacuum-heating system attached by bringing the 2-in. return pipe *A* in to connect at the bottom of the header through the valve *C*. The tee *D* was blanked off to allow heat to be used while waiting for pipe and fittings with which to connect the 3-in. suction line to the vacuum pump. The header was on the old system, and to allow the vacuum to act on all three return lines, the valves *E* and *F* were added, which, when closed, cut off the returns from the receiver, and by opening a 3-in. valve on the suction pipe *G* to the vacuum pump, and the valve *C*,



PIPING OF RECEIVER AND FEED PUMP

the entire heating system could be run as a vacuum return and much saving made. Or in case of accident to the vacuum pump the entire system could be run as a gravity-return system.

In running on the gravity-return system the returns pass through the valve *E* to the receiver and feed pump, and considerable water hammer occurs in the elbow *H* and tee *I* and the pump would frequently become airbound, although there was a vent pipe on the receiver.

It is my belief that considerable water passed from the 1-in. pipe from the water supply to the top of the header before the valve *F* was put in, thus forcing much vapor and air in the return pipes down into the suction pipe of the pump. While the pump was running, it would take the air from the pipe past the water flowing out from the receiver and become airbound. The water hammer and erosive action of the water ruined the threads in the elbow *H* and the tee *I* as well as the nipples, until brass fittings were put in.

Heat was put on the new portion through a ¾-in. pipe and a reducing valve before the large steam-supply main was connected to the engine room. The end of the pipe was not left open to blow out the scale and sand from the inside of the pipe, nor could it be blown out if it was desired, because there could not be raised over 3 lb. pressure through the ¾-in. pipe and reducing valve. This was further held back by thermograde return valves on the radiators.

The return came back for about six weeks through the line *A* by gravity without apparent trouble to this receiver and feed pump before the job was completed and the vacuum pump started. The vacuum pump ran well for a few weeks and gave no trouble. It was shut down to add another return line near the pump, and while this was being done the system was again run on gravity return with back pressure from the engine for half a day and then turned to vacuum again.

The next day the feed pump began to wheeze and would not pump. After removing the cylinder heads from the water end, the packing came out with a hole cut through the four rings on the bottom side as shown by *K;* and they were also grooved. The lining of the pump was quite badly scored, but there were no signs as to what had caused the scoring.

Packing has often cut through in this manner because misfitting joints allowed the water to spurt through until the velocity cut the packing. New packing was carefully fitted to break joints, and the pump ran well for eight weeks, then began the wheeze again. When the packing was taken out, it looked much like that shown at *L*, the specks and lines representing pipe scale and chips from pipe dies in cutting threads. A piece of brass chip ⅛ in. long and 1/16 in. wide was found embedded in the packing, as were all the other chips, and a quantity of chips and pipe scale were lying in the counterbore against the cylinder head.

It was evident that most of this grit had come from the larger mains through the drain-pipe connections to the return line and that the high-pressure live steam which was turned on at night had forced them from the pipe and through the drain-pipe thermograde valves. It is good policy to blow out all new pipe lines with the end open to free them from scale and grit before putting them in service, or to connect them to tanks where the grit cannot get into the pumps to destroy the linings and packings. It is my policy to connect return lines to the top of the receiver tank when possible.

The two old return lines and the 2-in. header should have been connected horizontally to a 2-in. vented pipe in place of the 1½-in. pipe *J*, which would have allowed air to escape and the water to enter the receiver without the use of the 1-in. pipe and the valve *F*, which would have prevented the damage to the fittings *H* and *I* and the pump becoming airbound. The two old return pipes as well as the new one could have been brought into the pumproom side by side instead of one above the other and both above the receiver; but being in this position, the new one was connected at the bottom as this did not bother when the system was run as a vacuum-return system and the fittings now being brass and not used much.

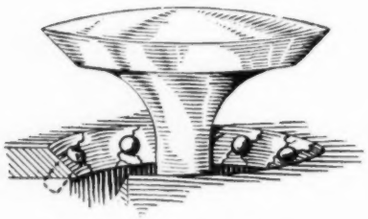
The only repair that could be made on the pump lining was to remove the water pistons, push the rods back as far as they would go and file the grooves as smooth as possible, as it would not pay to rebore them for the small amount of wear remaining in them before they would have to be replaced with new ones. It was impossible to blow out the steam main, as the pipes in the new building were in service and goods in process of manufacture in line to be damaged.

Cambridge, Mass. R. A. CULTRA.

Why Does a Leaky Compressor Valve Get Hot?

In the Nov. 16, 1920, issue Donald McFee asked for information as to why a leaky valve on an air compressor gets hot. His chief is right. A leaky discharge or suction valve on an air or an ammonia compressor gets very much hotter than with normal operating conditions, and the greater the leakage the hotter the valve will get. The reason is that the constant churning back and forth of the high-pressure air or gas past the valve through the leak prevents the cooler intake air or gas from keeping the valve at its normal temperature.

The work done on the air or gas by the piston produces a definite amount of heat, some of which is dissipated to the jacket water, and some by radiation through the metal of the piping and other uncooled surfaces. A certain definite temperature is reached normally during regular operation. Any leakage through the valve, due to the churning of the air back and forth, will produce a temperature higher than normal, hence feeding of the valve body or cages or the immediate vicinity will disclose any abnormal conditions that exist. This extra heat is produced whether the high-pressure air leaks back into the cylinder or the section valve allows air to return into the section lines, which is an atmospheric pressure, or discharges to the section pressure of ammonia compressors. In each case the result is the same.



PINS IN VALVE SEAT

I remember several instances of exhaust valves on oil and gas engines which developed severe cases of exhaust-valve destruction due to attendants' not stopping the valve leakage at the proper time. They thought that a day or two of operation would not hurt anything, but before they realized it they had to shut down in a hurry, as the exhaust valves had been practically destroyed, all owing to leakage.

A case of a 150-hp. producer-gas engine, where I was called in for repairing, is further cited. The exhaust-valve seat was an integral part of the head. The inlet valve was in a removable cage. Owing to changing engineers frequently at this plant, the engine was neglected until it gave considerable trouble from preheating. The noise it made while operating was terrific at times, and something had to be done.

I diagnosed the trouble as a severe case of leaky discharge valve. The gas tested all right, and the other engines were operating nicely. Upon shutting down and trying to remove the exhaust valve, I found that carbon had accumulated on the exhaust-valve stem to such an extent that we worked 26 hours with kerosene to soak the carbon, using rams and jacks before we finally got the valve out.

The seat of the head was badly warped and cracked in several places. Luckily, the cracks did not extend through to the water space. We improvised a seat cutter and obtained a good seat after several hours' work. New valves and stems were made at the local machine shops. The sketch shows how the seat cracks were repaired by drilling a hole in the center of each crack and driving in a soft-steel pin, well smeared with litharge and glycerin paste and then sawed off level. The valve was thoroughly ground in with carborundum and oil until a good seat was obtained. The pins acted as stoppers, and the engine operated for several years after the repairs without giving any trouble, needing only regular grinding in of the valves, etc.

Regular data for grinding in valves on air and gas or ammonia compressors would prove of benefit to all operators of Diesel engines. In fact, all operators of internal-combustion engines should have a regular routine of changing valves, grinding in and inspecting piston rings, and have regular intervals of so many hours' run and then look after things right; they will find that it pays in the long run. D. L. FAGNAN.

New York City.

Puzzling Air-Compressor Trouble

Among the four air compressors in my charge are two 900-cu.ft. per minute, two-stage machines with Corliss intake and poppet discharge valves, driven by 440-volt three-phase slip-ring motors; both compressors and motors are identical. One unit had been run about three and one-half years, the other about four months. We had never had any trouble with the older machine. For about six weeks the new machine behaved as it should, and then the trouble started.

These machines have a short belt drive with a floating idler. One morning on starting the new compressor the idler began to jump violently as soon as the unloader cut the machine in on the line. As the belt did not appear to be slipping, this action suggested a sticking discharge valve. The discharge valves were examined, but no carbon or gummy deposits were found. They were cleaned thoroughly and the machine then started properly and ran satisfactorily for a couple of days.

Another morning the idler began jumping so violently that the surge tripped the circuit-breaker on the motor. The valves were again cleaned and the trouble vanished, only to appear again two days later as bad as ever. This went on for about two months. We changed the compressor cylinder oil, examined all parts of the compressor and found nothing wrong.

Sometimes we would take out one or two valves, clean them, start up and go all right for a day or two; then taking out the same valves had no effect. Finally, we took to cleaning all valves every night after shutting down, and for about a week had no trouble. We had about come to the conclusion that the oil was responsible for our troubles when, on starting with the valves all clean, it was there worse than ever. On but one occasion had we any trouble after the machine was well warmed up, and this was when the machine had been running about thirty hours.

Three experts from compressor builders examined the machine and could find nothing wrong. Then I had a "hunch" that perhaps the surge of the machine when loaded might affect the contacts in the motor starting box, which was mounted on the motor base. Upon removing the cover from the drum-type controller, a poor contact was found on the fingers that short-circuit the slip rings when the motor is up to speed. The contacts had been hot, and some of the solder had melted out of one of the terminal lugs. When this was repaired, the machine started properly and has run satisfactorily for months. C. A. GREEN.

Cleveland, Ohio.

INQUIRIES OF GENERAL INTEREST

Condensation May Offset Gain from Expansion—Why is not cutoff of steam at one-fifth of the stroke, or less, as economical as one-fourth or one-third stroke? C. T. S.

Early cutoff and consequent high rate of expansion increase the amount of cylinder condensation on account of the extreme changes of temperature, and when the cutoff is earlier than about one-fifth, the condensation may offset any gain from increased expansion.

Variation of Water in Gage Glass—Why does the water rise and fall in the glass gage of a boiler when there is no variation in draft of steam or rate of feeding water to the boiler? E. E. R.

The water rises and falls in the glass gage because there is a variation of pressure in the boiler at the point where the water column is connected. This may be due to circulation of the water, or to variable rarefaction of the water from irregular formation of steam bubbles, or a surging of the water from being swept along by the steam bubbles in their ascent to the steam space of the boiler.

Allowance for Expansion of Steam Line—How much allowance should be made for expansion of a pipe 130 ft. long which is to carry steam at the pressure of 125 lb. gage? J. R.

The temperature of steam at 125 lb. gage is 353 deg. F., and assuming that the pipe is connected up at a room temperature of 40 deg. F., the range of temperature to be provided for would be $353 - 40 = 313$ deg. The coefficient of linear expansion of iron or steel is about 0.0000065, and the allowance for linear expansion should be $0.0000065 \times 313 \times 130 = 0.265$ foot, or about 3 3/16 inches.

Measuring Length Required for New Boiler Tubes—What allowance should be made in cutting the length of new tubes for a return-tubular boiler? L. F.

There is more or less irreguarity in the tube heads of a boiler, and measurements should be made for each tube separately by rodding the distance from outside to outside of the tube heads with a stiff wooden rod or gas pipe, small enough to pass through the tube holes. The measuring rod or pipe should be held flush with one tube head by a helper and marked close against the outside of the other head. When this outside distance between tube heads has been set off on the tube from one end, enough extra length should be measured off to allow for each end from two to two and one-half times the thickness of the tube, for beading.

Measurement of Three-Phase Power—If three-phase power is to be measured by means of two single-phase wattmeters, will the power in the circuit always be the sum of the two readings, or will unbalancing and variable power factors give inaccurate readings? J. J. P.

This method of measuring three-phase power is somewhat complicated, but the readings are accurate under all conditions of load and power factor. The power flowing in the circuit will be the sum of the two meter readings for power factors above 50 per cent. With 50 per cent power factors, one of the meters will read 0 and the other the full power in the circuit. Below 50 per cent power factor, one meter will reverse and it will be necessary to reverse either the current or potential coil in order to obtain a reading on the scale. It must not be forgotten that this will be a negative reading and should be subtracted from the other to obtain the total power.

Equalizing Cutoff of Corliss Engine—How is cutoff equalized in a single-eccentric Corliss engine? L. L. S.

Block the governor at the average running position and adjust the length of the governor reach rod to the crank end so the valve will be just tripped when the piston reaches about ¼ stroke from that end. Then place the piston at the same fraction of stroke from the head end and adjust the length of governor reach rod to that end, first so the valve will not be tripped for any shorter cutoff, and then gradually adjust the rod so that the valve will be just tripped with the engine in that position. Then block the governor a little higher or lower and test whether the cutoffs are nearly the same.

Testing Valve Leakage of Single-Valve Engine—How can a test be made of valve leakage of a slide-valve or single-valve automatic engine? C. J. Y.

A general test of tightness can be made by turning the engine over to such a position that the valve covers the ports of both ends of the cylinder at the same time. Then, upon admitting steam at the throttle valve, leakage will be shown by discharge of steam from open cylinder pet cocks or indicator connections, or by escape of steam from the exhaust pipe. The leakage under running conditions can be approximately determined by blocking the engine wheel and making tests at different points of stroke of the piston. To test valve leakage of a throttling D slide-valve engine at a given point of piston stroke from the crank end of the cylinder, remove the cylinder head and with the piston in the crank end of the cylinder, turn the wheel in the running direction, and block the wheel when the piston has arrived at the desired point; then gradually admit steam through the throttle and observe whether there is escape of steam from the steam passage of the head end into the cylinder or out of the exhaust pipe.

Piston leakage must be corrected before it is attempted to inspect leakage of the valve when it is in position for admission of steam for a piston stroke from the head end of the cylinder, because the crank end of the cylinder cannot be uncovered to distinguish piston leakage from valve leakage. When the piston packing has been made tight and cylinder head replaced, turn the engine wheel in the running direction until the piston has arrived at the desired point of stroke from the head end of the cylinder. Then with the wheel blocked, open the throttle a little, and steam escaping from the exhaust pipe, or the cylinder pet cock or indicator connection of the crank end, will indicate the valve leakage.

With a single-valve automatic engine, proceed the same as for testing valve leakage of a throttling engine, but with the governor blocked in its average running position, and positions giving other points of cutoff of which it is desired to test valve leakage.

[Correspondents should sign their communications with full names and post office addresses.—Editor.]

Interpretations of the A. S. M. E. Boiler Code

REQUESTS for interpretations of the Boiler Code are acted upon by the Boiler Code Committee, their formulated replies being submitted to the Council of the American Society of Mechanical Engineers. The inquiries and replies are published from time to time in *Power* with such explanatory comments and illustrations as seem advisable for a clear understanding of the interpretations on the part of engineers in general. The last group of interpretations published in *Power* was in the issue of Dec. 14, 1920.

Case No. 312 (Reopened)—Inquiry: Is it necessary in the construction of small Star-type water-tube boilers for steam heating, which are to carry more than 15 lb. pressure at times, to drill the inside and outside ends of staybolts? It is believed that it was the intention of the committee to cover

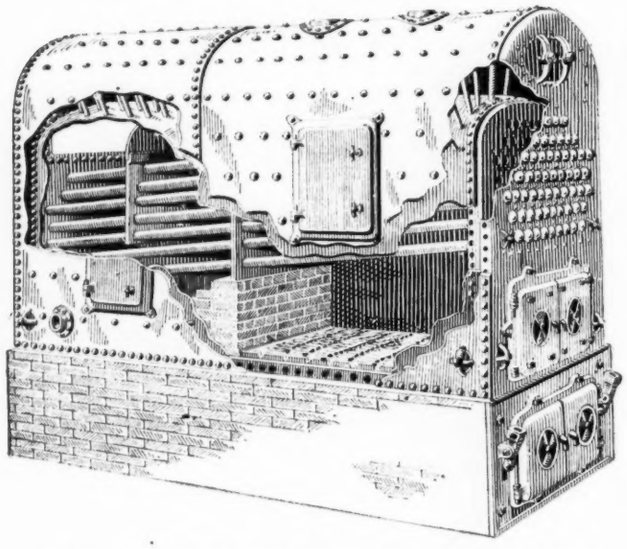


FIG. 1. BOILER OF THE "STAR" OR "OSWEGO" TYPE

in this requirement the water legs at front and back ends, which are considered as headers.

Reply: If the grate area is more than 15 sq.ft., the staybolts are less than 8 in. in length, and the pressure exceeds 15 lb., it will be necessary to drill the staybolts in order to comply with the Code requirements. It is the opinion of the committee that the staybolts in the side sheets and that portion of the tube sheets below the tubes of boilers of this type need be drilled only on the outside ends as required in a boiler of the locomotive type, but that the staybolts in that portion of the tube sheets containing the tubes should be hollow or drilled at both ends as required for the water legs of water-tube boilers.

Par. 200 provides that the ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of sol'd staybolts 8 in. and less in length shall be drilled with a hole at least $\frac{5}{16}$ in. in diameter to a depth extending at least $\frac{1}{2}$ in. beyond the inside of the plate, or hollow staybolts may be used. On boilers having a grate area not exceeding 15 sq.ft. or the equivalent in gas- or oil-fired boilers the drilling of staybolts is optional. Solid staybolts over 8 in. long and flexible staybolts of either the jointed or ball-and-socket type need not be drilled. Staybolts used in water legs of water-tube boilers shall be hollow, or drilled at both ends, irrespective of their length.

The Star type of water-tube boiler (or, as its sponsors now prefer to have it called, the Oswego) is, as shown in Fig. 1, shaped something like the crust of two loaves of bread placed one inside the other, with a space between, the ends of the inside crust being connected by water-tubes placed at a slight angle with the horizontal.

Case No. 313—Inquiry: Is it permissible, under the requirements of Par. 186 of the Boiler Code, to join by autogenous or fusion welding, the butting edges of flanged plates to form the water legs of detached smokeless fire-boxes, where the stress due to the steam pressure is fully carried by staybolting?

Reply: The welded construction described is allowable under the rules of the Code provided the strength of the structure is sufficient to meet the Code rules without making any allowance for the holding power of the weld.

Par. 186 provides that autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the welds.

Case No. 318—Inquiry: Is it permissible, under Par. 331 of the Boiler Code, to omit the stamping from completed shells of miniature boilers which are formed by a cupping or hot-drawing process in which the stamping is necessarily obliterated?

Reply: It is the opinion of the committee that the intent of Par. 331 would be met if a record of the heat numbers taken from the plates were checked with the mill test reports, and if found to meet the Code requirements the inspector may authorize the manufacturer to proceed with cupping the plates, after which the manufacturer is to stamp the shell, in the presence of the inspector, with a lot number which will identify the sheet with the test sheet record.

Par. 331 provides that in laying out shell plates, furnace sheets and heads in the boiler shop care shall be taken to leave at least one of the stamps specified in Par. 36 so located as to be plainly visible when the boiler is completed, etc.

Case No. 319—Inquiry: Is it allowable, under the requirements of Par. 308 of the Boiler Code, to connect to a boiler to be operated at a pressure exceeding 15 lb. and not to exceed 100 lb. for the return of condensation to a heating system, a 4-in. return connection, this same return connection being used as a blowoff, but the blowoff connection therefrom being reduced, however, to $2\frac{1}{2}$ in. pipe size or less?

Reply: It is the opinion of the committee that such a connection for return of condensation will not be in accordance with the requirements of Par. 308 of the Code. It will be necessary to use an independent connection for the return.

Par. 308 provides that each boiler shall have a bottom blowoff pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable. The decision of the committee is evidently to the effect that regardless of the size of pipe or fittings a return connection used as a blowoff cannot be considered as a bottom blowoff pipe; or in other words the terms cannot be construed as synonymous.

Case No. 320—Inquiry: Will it meet the requirements of Par. 303 of the Boiler Code where a non-return angle valve is mounted directly on the steam-outlet nozzle of a boiler, and to the outlet of this valve there is bolted a gate valve, forming the two stop valves required, to provide the ample free-blow drain between the two valves by a $1\frac{1}{4}$-in. pipe tap in the side of the non-return angle valve just above the seat, in order to avoid the necessity of placing a fitting between the two valves?

Reply: It is the opinion of the committee that such a construction will fully meet the requirements of Par. 303.

Par. 303 provides that when two or more boilers are connected to a common steam main two stop valves with an ample free-blow drain between them shall be placed in the steam connection between each boiler and the steam main, etc.

The committee considers drainage provision at some point between the valve seats as equivalent to one between the valves themselves. It should be noted, however, that for this arrangement most valve bodies will require reinforced castings in order to comply with Par. 300 of the Boiler Code.

Case No. 321—Inquiry: Is a boiler of the porcupine type where stub tubes are screwed in the furnace sheet subject to the requirements of Par. 250 of the Boiler Code, or is the screwed connection of such stub tubes permissible?

Reply: Par. 250 refers specifically to fire-tube boilers and is therefore not applicable to a boiler of the porcupine type in which the tubes are operated under conditions similar to those of the water-tube type of boiler. Par. 251 refers to tubes which are expanded into the tube sheets and does not apply to tubes with screwed ends. It is the opinion of the committee that the pipes or tubes should meet the requirements recommended by the committee in the reply for case No. 296—that special redrawn pipe, not to exceed $1\frac{1}{2}$-in. standard pipe size made from lap-welded iron of puddled stock and tested to 1,000 lb. hydraulic pressure, may be used

for a working pressure not to exceed 200 lb. per sq.in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers. The minimum number of threads should conform with the values given in Table 8 of the Code. The closed ends of the stub tubes may be welded by the forging process.

Par. 250 provides that a fire-tube boiler shall have both ends of the tubes substantially rolled and beaded; or rolled and welded at the firebox or combustion-chamber end. Par. 251 states that the ends of all tubes, suspension tubes and nipples shall be flared not less than $\frac{1}{4}$ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than $\frac{1}{8}$ in., rolled and beaded, or flared, rolled and welded.

In Case No. 296 the question was asked, "Will a water-tube boiler of a type largely used in marine service, the heating surface of which is constructed mainly of iron pipe screwed into malleable iron and steel fittings, meet the requirements of the Boiler Code, 'f the pipe used is a special quality of redrawn lap-welded iron pipe of puddled stock and tested to 1,000 lb. hydraulic pressure?"

The reply of the committee was as follows: "There is nothing in the Boiler Code to cover the use of iron pipes for the tubes of such a boiler with screwed joints. Until such a time that the specifications for piping have been formulated the Boiler Code Committee would consider that if the other requirements of the Boiler Code are met special redrawn pipe, etc."

The rest of the reply corresponds with that of Case No. 321 up to and including the words "water-tube boilers."

Case No. 322—Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for safety-valve body for safety valves to be operated at a pressure of 225 lb.? May cast iron be used for this purpose?

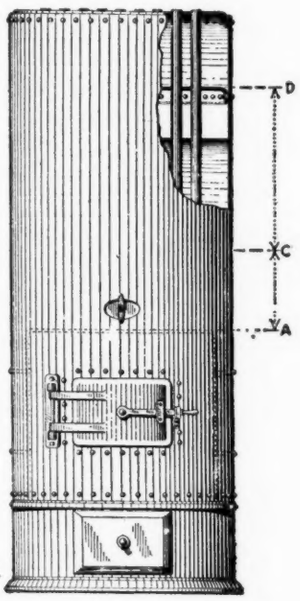


FIG. 2. LOWEST ALLOWABLE POINT FOR FUSIBLE PLUG IS C, ONE-THIRD THE DISTANCE FROM A TO D

Reply: Under the requirement of Par. 9 it is necessary that the Y-fitting be constructed of steel, but the safety-valve body need not be of steel unless to operate with superheated steam (see Par. 289).

Par. 9 provides that cross-pipes connecting the steam and water drums of water-tube boilers, headers, cross-boxes and all pressure parts of the boiler proper, over 2-in. pipe size, or equivalent cross-sectional area, shall be of wrought steel or cast steel of Class B grade, as designated in the Specifications for Steel Castings, when the maximum allowable working pressure exceeds 160 lb. per sq.in. Par. 289 provides that every safety valve used on a superheater, discharging superheated steam, shall have a steel body with a flanged inlet connection and shall have the seat and disc of nickel composition, or equivalent material.

Case No. 323—Inquiry: Does Par. 380 cover all classes of lap-seam boilers including boilers of the locomotive type, or does it apply solely to h.r.t. boilers? Is it the intent of the Boiler Code that the drums of water-tube boilers over 36 in. in diameter and over 20 years of age come under the requirements of Par. 380?

Reply: It was the intent of the committee that the application of Par. 380 should be limited to h.r.t. and similar types of fire-tube boilers, the shells of which are exposed to the fire or products of combustion. It was not intended that Par. 380 should apply to the drums of water-tube boilers, or boilers of the locomotive type.

Par. 380, in Part II of the Boiler Code—Existing Installations—provides that the age limit of a horizontal return-tubular boiler having a longitudinal lap joint and carrying over 50 lb. pressure shall be 20 years, except that no lap-joint boiler shall be discontinued from service solely on account of age, until five years after these Rules become effective.

Case No. 327—Inquiry: Is it necessary, under Par. 430d, that the fusible plug must be located in a tube not less than one-third the length of the tube above the lower tube sheet where such a boiler is fitted with an extra head and a water-heating compartment at the top of the sheet?

Reply: It is the opinion of the committee that where a top compartment is utilized for preheating of feed water, the measurement of the tube may be construed as applying to that portion of the tube between the firebox tube sheet and the point where the tube enters the top compartment.

Par. 430 of the Code provides that in vertical fire-tube boilers fusible plugs shall be located in an outside tube not less than one-third the length of the tube above the lower tube sheet. For boilers of the type described in the inquiry it is evident that a strict interpretation of the rule as it stands, might in extreme cases, or in those assumed for theoretical illustration, bring the location of the plug near or even above the water line. The Committee, therefore, rules that plugs for this type of boiler may be located as shown in Fig. 2.

Case No. 329—Inquiry: What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

Reply: It is the opinion of the committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in Par. 88 of the Code.

Case No. 330—Inquiry: Is it permissible to repair cracks in the tube sheets of water-tube boilers by autogenous or fusion welding? In the recommendations in the Appendix, it states that no welding shall be allowed in cracks in steel plates or other plates subject to tensile strain, yet it is stated that where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness, the same may be reinforced and repaired by any process of autogenous welding.

Reply: It is the opinion of the committee that such process of reinforcing and repairing may only be used on tube sheets which are not subject to tensile strain, as permitted by the Appendix.

The last paragraph of the Appendix reads: "Where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness or where cracks have developed in tube sheets the same may be reinforced and repaired by any process of autogenous welding, and the beading on the ends of tubes may be welded to the tube sheet by the same process." The seventh paragraph preceding, however, reads: "No welding shall be allowed in cracks in the shell plate or other plates subject to tensile strain."

A. S. M. E. Active in Research Work

According to Arthur M. Greene, Jr., chairman of the A. S. M. E. Research Committee and professor of mechanical engineering at the Rensselaer Polytechnic Institute, the research committee is carrying on an extensive work through its special committees for specific researches and its "Research Section" in *Mechanical Engineering*, the journal of the society.

The special committees so far organized are actively engaged in studying the following subjects: Bearing metals, lubrication, the accuracy and permanency of indicating instruments, flow-meters for measuring steam, water and other fluids, heat transfer, and the present position of science regarding the strength of riveted joints and shafting under torsion.

In addition to working through these committees, however, the main research committee publishes each month notes gathered through its correspondence with laboratories all over the United States. These notes give the results of interesting researches, news of investigations that are being carried on, problems on which information is requested, particulars as to the equipment of various laboratories, personnel news and bibliographies which have been prepared in the extensive Engineering Societies Library in New York.

"The object of the research committee as constituted at present," in the words of Professor Greene, "is to stimulate research by the publication of data, to organize and direct special researches of a general and important interest and to serve the profession as well as possible in this field. Service and co-operation with knowledge and thoroughness is its motto."

Production of coal and briquets in Germany for the first nine months of 1920 reached a total of 270,445,430 tons. Of this amount 119,420,430 tons was hard coal, 101,523,999 tons brown coal, 22,822,485 tons coke, 4,484,128 tons briquets of hard coal and 22,194,348 tons briquets of brown coal.

Midwinter Convention of the A.I.E.E.

WEDNESDAY evening, Feb. 16, the ninth Midwinter Convention of the American Institute of Electrical Engineers was formally opened by President A. W. Berresford. In his address the speaker reviewed the rôle of the engineer in modern civilization, emphasizing the fact that the increasing importance of this rôle was the natural result of the rapid growth in the magnitude of modern enterprises and the increasing application of science to all phases of modern life. As the engineer evolves to meet his added burdens, he is daily being forced into closer association and co-operation with his professional brothers. The day is gone when he can stand alone and grapple with the engineering problems of the times. They have passed beyond the grasp of the individual, and must be solved by the profession as a whole. Herein lies the secret of the growth and vitality of the engineering societies, which are the concrete answer to the call for co-operation. On the other hand, the inevitable result of the new bond of fellowship between members of the profession is to foster among them a new spirit, to substitute for the base motive of private interest, the nobler one of unselfish public service.

The remainder of the evening was given over to the subject of oil circuit-breakers, under the auspices of the Protective Devices Committee of the Institute. The chairman of the sub-committee on Oil Circuit-Breakers and Switches, H. R. Woodrow, of Stone & Webster, presented the first paper on the "Limitations of Oil-Circuit Breakers in Present-Day Practice."[1] The speaker exposed the recommendations and conclusions of the committee, deduced from the answers to a questionnaire sent out to large power companies and users.

Philip Torchio, of the New York Edison Co., on "High-Current Tests on High-Tension Switchgear,"[1] set forth a remarkable series of tests on the operation of oil circuit-breakers, disconnecting switches, current transformers and fuses, under heavy short-circuit current. The tests were not meant to cover the interrupting operation of breakers, but only to observe their behavior under heavy currents.

Higher Temperatures for Cables

The Thursday morning session was given over to the discussion of "Permissible Operating Temperatures of Low Tension Paper-insulated Cables," the object being to decide on the advisability of raising the existing A. I. E. E. standard of 85 deg. C. continuous operating temperatures. The first speaker, W. A. Del Mar, quoted a series of tests, one set performed upon impregnated and non-impregnated paper, and another set upon short lengths of lead-covered paper-insulated cable sealed at both ends and kept for several weeks at the temperature of 100 deg. C. From the results of tensile and tearing tests upon the paper submitted to this treatment, the speaker concluded that temperatures of 100 deg. C. continuous are destructive to paper insulation.

Philip Torchio, of the New York Edison Co., took the opposite view. Quoting a report of Steinmetz and Lamme, 1913, a series of tests by the British Engineering Standards Committee, 1905, and field surveys and careful tests made by him on long sections of lead-covered cables in ducts under conditions of every-day practical operation, he drew the following conclusions: That paper in a lead-covered cable is under much more favorable conditions than when exposed to the air, and under those conditions resists deterioration by heat at least as well as varnished cambric exposed to the air, for which the Institute allows continuous temperatures of 105 deg. C.; that the permissible operating temperatures should be a function of the load factor, inasmuch as the deterioration to paper insulation depends as much upon the time during which it is subjected to a high temperature as upon the temperature itself. He therefore proposes that the allowable maximum continuous temperatures for lead-covered paper-insulated low-tension cables be graded as follows: 105 deg. C. for 33 per cent load factor, 95 deg. C. for 50 per cent load factor and 90 deg. C. for 66 per cent load factor or over.

[1] Abstracts of these papers will appear in an early issue.

D. W. Roper, of the Commonwealth Edison Co., Chicago, told of several investigations conducted under his direction into the operating temperatures in duct systems, during which temperatures considerably above 100 deg. were measured, yet the insulation was found to be in good condition in all cases where cables were withdrawn, and these were reinstalled in other locations without injury. Only in one case was the insulation damaged by the heat, and that was in the vicinity of a hole in the lead sheath, where the insulation was badly charred. The speaker concluded that the lead sheath plays an important part in the life of paper insulation under high temperatures and that deterioration is much more rapid when this is removed and the paper becomes exposed to the air. In his opinion, copper temperatures of 110 deg. C. are permissible continuously and have little effect on the insulation provided the lead sheath remains intact, whereas copper temperatures of 180 deg. C. applied for any appreciable length of time have proved destructive. He expressed the opinion, however, that further investigation is necessary before the Institute ruling is made to this effect.

Conservatism Advised

Wallace S. Clark, of the General Electric Co., outlined a series of tests on lengths of three-conductor lead-covered paper-insulated cable subjected to temperatures ranging from 68 deg. C. to 110 deg. C. for varying periods. The samples were carefully sealed, and it is to be surmised that the test conditions approximated those of practical operation. From the results the speaker concluded that, in lead-covered cable, deterioration is negligible at 70 deg. C. continuous; is marked in 90 days at 100 deg. C. continuous, and in 30 days at 110 deg. C. continuous.

H. W. Fisher and R. W. Atkinson, both of the Standard Underground Co., dealt specifically with the effect of heat on impregnated paper. From a series of tests performed by heating paper in impregnating compounds, the authors drew the following conclusions: That, for continuous operation the temperature should not exceed 78 deg. C.; for maximum temperature maintained five hours a day, 85 deg. C.; for maximum temperature maintained 2½ hours a day, 90 deg. C.; for maximum temperature maintained one-half hour a day, 100 deg. C.

L. L. Elden, of the Edison Electric Illuminating Co., of Boston, presented the results of a long series of observations of cable loadings and temperature during eleven years, showing marked conservatism, inasmuch as the allowable limit of 85 deg. C. was probably never reached on any cable during that period. The speaker cited in justification of this policy the excellent record of the cable system under consideration, where in eighteen years of service, not one failure could be charged to loading conditions. The speaker questioned the practicability of any proposed system of cable rating based on the load factor of the system as a whole, since every cable has a load factor of its own; he further pointed out that load factor makes no distinction between seasonal loadings, regardless of the fact that cables may be operated at much heavier loads in winter than in summer. In conclusion he expressed his belief in a conservative policy, and doubted if the present Institute ruling should be changed.

Thursday afternoon was given over to telephony and telegraphy. Two papers were read, one on "Carrier-Current Telephony and Telegraphy," by E. H. Colpitts, Western Electric Co., and O. B. Blackwell, American Telephone and Telegraph Co., the second on "Some Phases of Railroad Telegraph and Telephone Engineering," by Stanley Rhoads, New York Central R.R.

On Thursday evening a dinner-dance was held at the Hotel Astor. The event was a greater success than ever before, over 500 members and guests being present.

On Friday morning, Feb. 18, B. H. Smith, of the Westinghouse Electric and Manufacturing Co., described a method for transmitting quantitative signals at a distance. This is accomplished by means of frequency, and is used on the C., M. & St. Paul R.R., to transmit to the dispatcher's office

accurate measurements of the power drawn by each substation along the 200 miles of line. The principle of the method is to control by means of wattmeters the speed of small synchronous generators, so that their frequency is directly porportional to the power measured by the wattmeter. Means are provided at intermediate substations to add frequencies, the final frequency received at the dispatcher's office being the sum of those generated at each substation along the line. The great advantage of this system over that using current for quantitative transmission of measurements is that frequency is unaffected by leakage of current, resistance, inductance or capacity in the line. The speaker claims an error of less than 2 per cent on the power measurements so transmitted.

The second paper, by James A. Cook, of the New York Edison Co., described a method for the measurement of relative eddy current losses in stranded cables, the object being to provide a means of comparing the various methods used in practice to decrease eddy current losses in cables.

Frederick S. Dellenbaugh, Jr., of the Massachusetts Institute of Technology, described a most ingenious electromechanical device for the rapid harmonic analysis of complex periodic waves, based on the schedule method of analysis.

Limitations of Stop Watches

A. L. Ellis, of the General Electric Co., covered an unusual subject of vital interest to the engineer—the limitations of the stop watch as a precision instrument. The speaker illustrated by slides the mechanism and principal defects of the best-known makes of American and European stop watches and showed that the best of them, if mechanically perfect as to workmanship, may yet show errors as high as two-fifths of a second on any time measurement, owing to jumping of the needle on starting and stopping and to other errors inherent to the design. Thus two mechanically perfect watches handled by experts may, when timing the same event, show a difference of four-fifths of a second. The speaker strongly advised that two watches at least be used simultaneously when timing an event.

The first paper on Friday afternoon, by R. E. Doherty and E. T. Williamson, dealt with the "Short-Circuit Current of Induction Motors and Generators." The subject was of particular interest as it has been proposed to install more induction generators in future plants, owing to the prevailing belief that these machines cease to generate when short-circuited and for this reason do not cause heavy currents in the circuits. The authors proved by careful oscillographic tests on a 150-hp. induction motor that the initial rush of current in induction machines on short-circuit is large, and comparable in every respect to that of synchronous machines, depending in both types on the leakage reactance of the windings. The only difference between the two types is that the heavy currents continue for a much longer period in the synchronous than in the induction machine, and drop to a constant "sustained" current which lasts until the circuit is opened, whereas in the induction machine the short-circuit current drops to zero in a few cycles.

The second paper, by W. Fondiller, of the Western Electric Co., and W. H. Martin of the American Telephone and Telegraph Co., dealt with the hysteresis effects with varying superposed magnetizing forces of different frequencies, more specifically from the point of view of the operation of loading coils on a telephone and telegraph line, when carrying both telegraph and telephone currents, and the "flutter" troubles encountered in those lines.

The closing paper, by Carl J. Fechheimer, of the Westinghouse Electric and Manufacturing Co., was a very scholarly treatment of the longitudinal and transverse heat flow in slot-wound armature coils. The author deduces rational formulas for which he computes coefficients from experimental data. The information should be of considerable value in the design of high-speed machines of great core length.

Edison Medallist Is Eloquent

The closing feature of the convention was the presentation of the Edison medal to Michael Idvorsky Pupin, "For Work in Mathematical Physics and Its Application to the Electrical Transmission of Intelligence." The presentation was formally made by President Berresford. Upon receiving the medal, Dr. Pupin made an address on "Wave Transmission," which was something of a surprise to his hearers. Instead of going into an abstruse dissertation on difficult scientific theories, Dr. Pupin told a delightful story of his early study of the subject of wave transmission and how he came upon the inventions for which he has received the highest honor that America can accord any man for achievement in electrical science.

Dr. Pupin told how, when he was a 12-year old boy in his native village in Serbia, he was one of a number who helped a shepherd watch a herd of oxen through the summer nights. This was the way in which he spent his vacation from school, and he said it was the best summer school he had ever attended, because it was here that he first took up the study of wave transmission and began to develop his ideas on the subject. It seems that the Serbian night was very much blacker than the ace of spades, so that the young shepherds had to depend on their hearing rather than their sight in keeping track of their charges. They, therefore, made something of a study of sound and trained their ears so that by listening to the ground, they could determine very closely the position of the oxen by the sound of their trampling. This, he declared, was the beginning of his study of science, for "science," he said, "is nothing more nor less than the gradual evolution in our minds of physical concepts." He naïvely pointed out that in the late war it was discovered that it was possible to hear sounds distinctly through a considerable thickness of solid rock, but that he had known of this back in 1870 in his little Serbian town.

DR. M. I. PUPIN, 1921 EDISON MEDALLIST

In thanking the A. I. E. E. for the honor conferred upon him, Doctor Pupin took occasion to make a generous acknowledgment of the work that others have been doing in the field of electrical research.

Hydro-Electric Power Plant at Fully, Switzerland

Aside from its up-to-date engineering features the hydro-electric power plant recently installed at Fully, Switzerland, is of interest as utilizing a net hydraulic head of 5,412 ft., probably the highest in the world. The plant is near Martigny in the Rhone Valley and depends for its water supply upon an Alpine lake situated about 10,000 ft. above sea level. Four Pelton wheels are fed by a pipe line about three miles in length, connected to a tunnel 550 yd. long which is partly under pressure. The generating station contains four sets of 3,000-hp. turbines running at 500 r.p.m., each operated by a single jet which strikes the wheel horizontally at its lowest point.

The wheels have an over-all diameter of 12 ft. and are of forged steel. They each carry 54 buckets and are so designed that no part of either the disc or the bucket is subjected to a tension higher than 13,200 lb. per sq.in., even in case of runaway. As each bucket is exposed more than eight times a second to the blow of the jet leaving the pipe at a velocity of about 590 ft. per sec., the method of fixing required careful study. The buckets have to resist the vibration produced by the continual blows and also the centrifugal stress of about 13 tons tending to force the bucket off the disc in the event of runaway. The wheel itself is fixed on the turbine shaft by means of a cone keyed to the shaft. This gives a true centering for the disc and allows of rapid dismantling if necessary. The end of the shaft on the alternater side is provided with a forged coupling disc, while the other end is direct-coupled to the oil pump of the governor. The shaft is supported in two self-lubricated bearings mounted on a frame incorporated with the bedplate, which also carries the wheel case, the governor and the jet pipe. This cast-iron bedplate also forms a rectangular funnel below the wheel which leads the outlet water from the turbine to a horizontal steel pipe 4½ ft. in diameter and 33 ft. in length. This pipe issues from the power house on the side opposite the inflow of the water and empties into the tailrace canal. At its outlet a sheet-iron baffle holds up a certain depth of water and forms a deadening pool to break the velocity of the jet when deviated under the wheel by the deflection at times of sudden unloading.

It is claimed that a maximum efficiency of 82.3 per cent has been shown by tests, and that about 5 per cent of the normal power is absorbed by bearing losses and in overcoming air friction.

The German Coal Situation

After several months of heated discussion public excitement surrounding the problem of the socialization of the German coal mines has somewhat abated, but only temporarily.

Lively times are sure to come when the first reading of the bill occurs. Close observers are gaining the conviction that the socialization has become an object of party warfare, with the ultimate design to upset the present government. The responsibility of forming such momentous decisions in the present unsettled state of affairs in Germany is weighing heavily on all responsible legislators and there seems to be no chance of a clear majority for any bill that would cause a radical alteration of present conditions.

Coal socialization as a center of public interest is superseded by the coming plebiscite in Upper Silesia, by which it will be decided whether the province will fall to Poland or will remain German. Upper Silesia is one of the richest German provinces, and political strife for it is running high between Germans and Poles.

Upper Silesia, which in 1871 had only 131,000 inhabitants, has now 2,200,000, of which 356,000 are employed in mining and other industries. The province contains in a narrow space probably more mineral wealth than any other part of the continent. Coal forms the lowest stratum with zinc, lead and rich deposits of iron ore above. The loss of Upper Silesia would be an enormous blow to Germany and greatly impair her economic strength.

In Lower Silesia, which, in November, 1920, produced 423,000 tons of coal, the production has come very near that of 1913. A further increase of production is expected from the conclusion of an agreement with the miners for longer shifts. An improvement is also noticeable in Saxony, where the production in November was larger than in October in spite of the shorter working time.

Germany's coal situation, although still precarious, is on a fair road to improvement. The twenty-four million tons per year that she must supply to the allied countries under the Spa treaty are nearly made up by the quantity by which the production has increased since last year. The present production would, however, just about cover Germany's own needs on the basis of the consumption of the last pre-war years.

A new development which is almost equivalent to socialization is in progress in Jugo-Slavia. The Jugo-Slavian government has recently decided to establish a central office in Belgrade for the control of the country's coal production and to regulate the prices of coal produced in private mines in such a way that the owner will receive a share in the profits and a fair return for his investment. He will, however, be compelled to appropriate part of his profits to increase the production.

An arrangement has lately been made between Germany and Czecho-Slovakia with regard to the exchange of German coal and coke against Bohemian brown coal. Germany undertakes to supply monthly 105,000 tons of coal and coke, mostly from Silesia, whereas Czecho-Slavakia will furnish to Germany 202,000 tons of Bohemian brown coal and 4,000 tons of coal from the Pilsen district.

Australian Steam-Electric Plant To Use Fifty-Cent Coal

Construction is to be started April 1 on a 125,000-kw. steam-electric plant, 112 miles from Melbourne, Australia, according to announcement from Australian government offices. This is a governmental undertaking, to be carried out by the Victoria Electricity Commission, which proposes to develop extensive coal deposits at the plant site, use the coal for generating electrical energy and transmit the power electrically to Melbourne and other industrial centers. Included in the project, for which immediate construction is planned, are a total of 1,800 miles of high-tension transmission line and three terminal substations. The trunk-line voltage will be 132,000.

The coal deposits are said to be very extensive, enough being available within a half-mile radius of the power house to operate the new plant for 150 years. The coal is found under an overburden of 33 ft. depth and can be delivered to the power house for about 50 cents per ton, the report states. Condensing water is supplied by a river alongside the power house. A single building is to be provided for engine room and boiler plant, while control apparatus and offices will be housed in a second structure. Transmission will be over a two-circuit steel tower line with towers spaced 1,000 to 1,500 ft. apart, these long spans being deemed most economical for the high-tension insulators to be used.

Coal Production Falling Steadily

Production of soft coal has been dropping off since the middle of December, 1920, at the practically constant rate of about half a million tons a week. According to the latest figures of the Geological Survey the output of bituminous coal, including lignite and coal coked, was 8,045,000 net tons for the week ended Feb. 5, as compared with over 12,000,000 tons, reached in December.

The average production per working day was 1,341,000 tons, which may be compared with 1,790,000 tons for the coal year (beginning April, 1920,) to date. The figures for the last few weeks have been paralleling very closely those for the corresponding period of 1918-19; at that time the armistice had just been signed and the coal market was affected by a mild winter and large stocks on hand, and so apparently history is repeating itself.

Watt's Early Pumping Engines

By John W. Grant

Among Watt's numerous examples of early contrivances collected for the Watt Centenary celebrations, few are of more interest than that of the pumping engine belonging to the old dry dock at the West Harbor, Greenock.

As far as can be ascertained, this engine must have been in use for fully 135 years, and it is still in good working order. It is shown in the accompanying illustrations.

Owing to the development of business enterprise at the port and the closing up of the harbor this memorable early

FIG. 1. NOTE THE ARRANGEMENT OF THE GOVERNOR BALLS

FIG. 2. OUTER END OF MAINSHAFT CONNECTED TO PUMP ROD

type of steam engine will be removed to the Watt Museum at Greenock.

The graving dock, which measures about 220 ft. x 50 ft., having a depth of about 10 ft. on the sill, was constructed by James Watt in 1785, so that taking this date the engine is about eleven years after Watt's Smethwick pumping engine at the canal near Birmingham.

As a civil engineer Watt designed the first graving dock in Scotland at Port Glasgow, in the year 1762. This dock is still in use.

Fig. 1 shows the admirable contrivance of Watt; namely, the "governing balls," which remains to the present day without any material alteration even in the best steam engines—the throttle valve for regulating the rate of admission of steam, and the centrifugal governor, a double conical pendulum which controls the speed by acting on the throttle valve and shows the balls hung on the ends of the pivoted arms. Fig. 2 shows the outer end of the main shaft connected to the pump rod for emptying the dock.—*Engineering.*

The A. S. M. E. Boiler Code has given entire satisfaction to the inspectors, manufacturers and users of steam boilers in Pennsylvania, according to the report of the boiler division of the Bureau of Inspection for 1919, which has just been received. Boilers inspected numbered 41,828, of which 17,098 were found to have ordinary defects, 1,606 were found to have dangerous defects, 82 were suspended and 12 condemned.

Secretary Daniels has recently been urging very emphatically that authority be given the President to lay embargoes on the exportation of oil to countries that refuse to allow American citizens to acquire oil lands within their borders.

The 1921 convention city of the N. A. S. E. is yet to be selected, although it is understood that Rochester, N. Y., has been eliminated.

Washington News

Power Commission Not Likely to Make Valuations for Over a Year—Senator Frelinghuysen Has Coal Bill of His Own—Two New California Water-Power Applications Received

By Paul Wooton
Washington Correspondent

Failure on the part of Congress to appropriate more than $100,000 for the annual expenses of the Federal Power Commission means that the development of the nation's water-power will be greatly retarded. The commission has before it applications covering more than 13,000,000 hp., but with the small force at its disposal, no great amount of headway can be made.

A deliberate attempt was made to repeal the Water-Power Act by indirection when the Senate adopted an amendment limiting the salaries to be paid to the Commission's chief accountant to $3,000 and to its engineers to $2,400. It is obvious that the commission cannot secure a competent chief accountant, or assistant accountants, for the maximum named when the Interstate Commerce Commission has difficulty of securing men at a salary of $9,000 to do work of an identical character. The Power Commission is required to pass upon plans and designs of large projects involving tremendous amounts of money. It would be impossible to carry on this work with an engineering staff that could be secured for a maximum salary of $2,400 a year. It is believed, however, that the Senate amendment will be eliminated from the Sundry Civil Bill in conference. The amendment, which originated with a single Senator, was adopted by the committee before it had a thorough understanding of the situation, and the Senate in turn accepted the judgment of the committee without inquiring into the merits of the appropriation. The Secretary of War in a letter of unusual frankness to the appropriation committees has asked that Congress take direct action if it is the intention that the Federal Power Commission shall not function.

Since there now is no chance of securing an appropriation in excess of $100,000 per year until July 1, 1922, it is not probable that the commission will undertake to make any valuations until that time. This delay in making valuations probably will cost the public many millions of dollars.

Prospects for the Calder Bill

As this is written, it is expected that the Committee on Manufactures of the Senate will report the Calder coal bill with a number of material changes. Owing to the lateness of the session, it is regarded as improbable that any legislation can be passed which would regulate the coal industry, but it is understood that the committee is willing to sacrifice the other provisions of the bill if it can secure the enactment of a law making it compulsory for coal operators and dealers to make returns to the Government.

Senator Frelinghuysen of New Jersey, who conducted an investigation of the coal industry at the last session of Congress, has announced that he will press his Coal Commissioner bill at the extra session. That measure provides a certain type of control, but is much less drastic than the one proposed by Senator Calder.

The bill regulating the handling of foods in cold storage has passed both the House and the Senate and now is in conference. One of the effects of this legislation, if the conferees can agree and the measure be added to the statutes, would be, it is believed, the material reduction of the amount of food held in cold storage. This, in turn, would have its influence upon the refrigeration industry.

The San Joaquin Light and Power Corporation, of Fresno, Cal., has applied to the Federal Power Commission for a license to develop water-power on the North and West Forks of Kings River in Fresno County, California. The power is to be used for public-utility purposes.

The Escondido Mutual Water Co., Hellman Building, Los Angeles, has applied for a license to develop water power on the San Luis Rey River in San Diego County, California. The power is to be used for public-utility purposes.

American Boiler Manufacturers' Association

The midwinter meeting of the American Boiler Manufacturers' Association was held at the Hollenden, Cleveland, on Tuesday, Feb. 22, with sixty-odd members in attendance. The forenoon was devoted to the discussion of committee reports on standard specifications for setting return-tubular and water-tube boilers, etc., and of the report of Charles E. Gorton, chairman of the Uniform Boiler Law Society, on the recent Detroit meeting of the National Board of Boiler and Pressure Vessel Inspectors. A resolution prepared by the Executive Committee commended the plans of this National Board for bringing about simplification of the stamping and registration of boilers, the examination and certification of inspectors and the uniform interpretation of the Boiler Code.

In the afternoon addresses were listened to from A. F. Lazarus, of the United States Chamber of Commerce, on "Overhead Expense," and John D. Strain, secretary of the American Plan Association of Cleveland, upon "The Open Shop."

A communication from the Worcester Electric Light Co.'s power department inquiring as to the policy of the association in the matter of purchasing current for the operation of their shops, especially from the point of view of its effect upon the sale of boilers, brought out the sentiment that every power user ought, in justice to his customers and in the interest of national efficiency, to procure his power in the most economical way; that where there was a considerable use of exhaust steam for heating or manufacturing processes, the works could run its own plant to advantage. The boiler plant in a boiler works is likely not to be of the best; it suffers like the cobbler's barefoot children, but one member told of a reduction in his coal consumption from over 20 to 9 tons a day, and the elimination of two men by putting in a model power plant.

Provision was made for closer co-operation with the Boiler Code Committee of the American Society of Mechanical Engineers in the matter of interpretations and revisions of the Code and also as to tolerances in its enforcement. A vote of sympathy and good cheer was tendered to J. D. Duggers, of the Kewanee Boiler Co., on account of recent physical misfortunes, and votes of thanks were passed to the speakers.

The annual meeting will be held at Bedford Springs, Pa., June 20-22.

Final Coal Report Completed

The Federal Trade Commission has submitted to Congress its report on the cost of producing bituminous coal in the States of Iowa, Kansas, Missouri, Arkansas, Oklahoma, Texas, Colorado, New Mexico, Montana, Wyoming, Utah, Washington and North Dakota. This completes the series of seven coal cost bulletins obtained by the commission at the direction of the President and in aid of the United States Fuel Administration.

Previous reports were: No. 1, covering the production of bituminous coal in Pennsylvania; No. 2, the production of anthracite coal in Pennsylvania; No. 3, the production of bituminous coal in Illinois; No. 4, the production of bituminous coal in Alabama, Tennessee and Kentucky; No. 5, the production of bituminous coal in Ohio, Indiana and Michigan, and No. 6, the production of bituminous coal in Maryland, West Virginia and Virginia.

In this report are shown the total f.o.b. mine cost (with its three major subdivisions of labor cost, supplies cost and general expense, including royalty and depletion), the sales realization received by the operators, and the margin between it and the total f.o.b. mine cost. For the total production of about 61,000,000 tons, the average annual total f.o.b. mine costs were given by districts as from $1.08 to $4.45, and the average sales realization, $1.36 to $4.66 per ton.

An analysis made for each district brings out the lower cost of production of the thicker seams mined, particularly in the item of labor. This has an important bearing in forecasting the effect which a change in the wage scale has on the cost of mines operating in seams of different thicknesses in a given field.

New Publications

THE BOILER BOOK. Compiled by H. E. Dart. Published by the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., 1920. Paper; 7 x 10 in. 65 pages; 20 illustrations. Price, $1.50.

As stated in the title page, this book is "a collection of reliable data for use in the design and installation of boilers and other pressure vessels." The author says in the preface that it is not intended as a treatise on boiler design, but merely as a collection in convenient form of data which he has found valuable in practice. As a matter of fact, it is replete with formulas, data and general information of great value to all having to do with the design, installation, operation and maintenance of steam boilers of all kinds. It is interesting to note that all drawings, tables and other data are in accordance with the provisions of the A. S. M. E. Boiler Code, which the Hartford Steam Boiler Inspection and Insurance Co. has adopted as its standard of information. The book is published in loose-leaf pamphlet form, facilitating its being kept up to date, and contains a copious index. The illustrations are in the form of blueprints, the reference and data tables are well spaced and conveniently arranged, and the volume will make a welcome addition to any engineering library.

Personals

T. O. Grisell has been appointed sales manager of the Green Engineering Co., East Chicago, Ind., succeeding Walter S. Burke, who has become the New York representative.

C. Wilkie, of the Merchants Ice and Coal Co., St. Louis, Mo., has been promoted to the position of chief engineer, succeeding Mr. Gass, who resigned at the first of the year. Mr. Wilkie will have charge of all plants and branches of the company.

Owen A. Jackson, for the last six years chief engineer at the Harvard Square power station of the Boston Elevated Railroad, is now chief engineer of the Salem Electric Light central station in place of William H. Barnard, who was for thirty-one years chief engineer and is now plant supervisor.

Carl A. Wendell, for the past few years chief engineer of the American Ore Reclamation Co. and previous to that with the United States Steel Corporation, has been retained by the General Briquetting Co., New York, as consulting engineer in connection with their flue-dust briquetting development. He will also specialize in coal washing and coal briquetting.

Society Affairs

The Engineers' Club of Philadelphia will devote its March 4 meeting to consideration of "Recent Developments in the Use of Superheated Steam."

Philadelphia Section, Association of Iron and Steel Electrical Engineers, will meet March 5 to hear a paper on "Methods Used to Insure Continuity of Service," by E. D. Sibley, of the Metropolitan Edison Co.

The American Institute of Electrical Engineers will hold its 368th meeting in New York City on March 11 under the auspices of the power stations committee. The subject will be "Development in Conversion Apparatus for Edison Systems."

The New England Water Works Association will hear a paper at its March 9 meeting on "Pipe Extension Charges," by Nicholas S. Hill, Jr., and an illustrated paper on "Cast-Iron Pipe, the Method of Manufacture, and its Inspection," by William R. Conard.

Miscellaneous News

Johns Hopkins University has arranged for a lecture to be given at 5.15 p.m., March 9, on "Present-Day Methods of Gas Making," by Col. Frederick H. Wagner, of the Bartlett-Hayward Co., in the auditorium of the Civil Engineering Building of the University at Homewood.

"Webster Method," monthly house organ of the Webster Manufacturing Co., Chicago, describes at some length in the February issue "The World's Largest Elevator," which has a capacity of 10,000,000 bu. of grain and deals also with a recently completed coal tipple.

Business Items

The Watson Engineering Co. has changed its general offices from 1101 Hippodrome Building to 4614 Prospect Ave., Cleveland, Ohio.

The Locomotive Superheater Co. has taken over the patents and business of the Locomotive Feed Water Heater Co. and has added to its force that company's operating organization.

The Vulcan Soot Cleaner Co., of Du Bois, Pa., has announced the appointment of G. L. Simonds as vice president in charge of Western sales with headquarters at 828 Transportation Building, Chicago, Ill., succeeding the Ernest E. Lee Co.

The Fisher Governor Co. and the Fisher Supply Co. of Marshalltown, Iowa, which have previously been conducted as two departments of a single organization, have been reorganized as separate corporations with individual management. The change was made necessary by a rapid increase in the volume of business of both departments.

Trade Catalogs

The Chicago Pneumatic Tool Co., New York City, has issued a new bulletin No. 607, describing its single-tandem oil-engine driven SO2 compressors, both stationary and portable.

Sauerman Bros., of Chicago have just issued an interesting 16-page pamphlet on "Handling Coal with Power Scrapers and Dragline Cableways." In the bulletin attention is called to the simplcity of the system and its flexibility in handling coal from storage to the overhead bunker in the power plant, the method of operation and the various applications possible.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoted	Feb. 15, 1921	Feb. 22, 1921
Pocahontas,	Columbus	$3.75@4.00	$3.50
Clearfield,	Boston	2.15@3.00	2.95
Somerset,	Boston	2.50@3.75	2.95
Pittsburgh,	Pittsburgh	2.25@2.50	2.20@2.50
Kanawha,	Columbus	2.50	2.60
Hocking,	Columbus	2.25@2.50	2.25
Pittsburgh No. 8	Cleveland	2.25@2.75	2.25@2.50
Franklin, Ill.,	Chicago	2.25@3.25	2.25@3.25
Central, Ill.,	Chicago	1.50@2.25	1.50@2.25
Ind. 4th vein,	Chicago	1.85@2.50	1.85@2.50
Standard,	St. Louis	1.90@2.00	1.90@2.00
West Ky.,	Louisville	2.10@2.50	2.00@2.25
Big Seam,	Birmingham	2.95@3.25	2.95@3.25
S. E. Ky.,	Louisville	2.50@2.75	2.50@3.00

DIESEL FUEL OIL

Chicago—24@28 deg. Baumé, $1.10@$1.20 per bbl.; 32@34 deg., 3½@4½ c. per gal.

Cincinnati—In 8,000-gal. tank cars; 26@28 deg., 9½ c. per gal., 30@34 deg., 10c.

Philadelphia—26@28 deg. fuel oil, 8½c. per gal.; 30@34 deg. gas oil, 10½c.; 16@20 deg. boiler oil, 6c.

St. Louis—Base plus freight: group 3 24@26 deg., $1.10@$1.25 per bbl.; 26@28 deg., $1.20@$1.35; 28@30 deg., $1.30@$1.45; 30@32 deg., $1.40@$1.55; 32@34 deg., $1.50@$1.65. No market for 16@20 deg. Baumé boiler oil.

New Construction

PROPOSED WORK

Me., Portland—The William Underwood Co., 52 Fulton St., Boston, Mass., is having plans prepared for a 6 story, 60 x 120 ft. factory. About $150,000. Monks & Johnson, 99 Chauncy St., Boston, Mass., Engrs.

Mass., Amherst—The Massachusetts Agricultural College is having sketches prepared for a physical laboratory. About $200,000. J. Ritchie and F. F. Jonsberg, 15 Ashburton Pl., Boston, Archts.

Mass., Boston—The Boylston Garage Co., Boyston St., is having plans prepared for a 6 story, 48 x 134 ft. garage. About $500,000. J. C. Spoffard, 36 Bromfield St., Archt.

Mass., Boston—J. Newman, 28 School St., is having plans prepared for a 5 story apartment house on Riverway Rd. About $350,000. W. L. Minor, 60 Pemberton Sq., Archt.

Mass., Brockton—E. J. Dreyfus, 17 Milk St., Boston, will soon award the contract for a 2 story 150 x 200 ft. store and office building including a steam heating system on Main St. About $250,000. A. H. Bowditch, 44 Bromfield St., Boston, Archt.

Mass., Brookline (Boston P. O.)—The Tenants Mutual Bldg. Trust, c/o John J. Smith, Archt., 1106 Old South Bldg., Boston, has had plans prepared for an 8 story, 120 x 240 ft. apartment house including a steam heating system on Louis Prang St. About $900,000.

Mass., East Boston (Boston P. O.)—The Boston School House Com. is having plans prepared for a 2 story elementary school on Lubec St. About $300,000. C. G. Loring, 7 Water St., Boston, Archt.

Mass., Fall River—The Dept. of Pub. Bldg. will receive bids until March 10 for a 1 story school on Bowen St., $125,000 and a 1 story grade school on New Boston Rd., $125,000. Steam heating systems will be installed in same. E. M. Corbett, 70 Bedford St., Archt.

Mass., Holyoke—The Hadley Falls Trust Co., 369 High St., plans to build an 8 story bank and office building on High St. G. P. B. Alderman & Bro., 316 High St., Archts.

Mass., Pittsfield—K. B. Miller, 125 Dawes Ave., will soon award the contract for a 3 story, 101 x 138 ft. theatre on Renue Ave. About $200,000. G. E. Haynes, 184 North St., Archt.

Mass., Roxbury—The Bd. Educ., Boston, is having plans prepared for a 2 story intermediate school on School St. About $500,000. J. Driscoll, 6 Beacon St., Boston, Archt.

Conn., New Britain—The Sacred Heart of Jesus Corp., Gold St., will soon award the contract for a 3 story, 75 x 180 ft. convent and dormitory including a steam heating system on North Burrit St. About $200,000. H. F. Ludorf, Mutual Bldg., Archt.

Conn., New Haven—The Masonic Temple Bldg., Assn., 87 Church St., is having plans prepared for a 4 story, masonic building on York St. About $500,000. Norton & Townsend, 839 Chapel St., Archts.

Conn., New Haven—The New Haven Hospital, 330 Cedar St., will soon award the contract for a group of hospital buildings including a nurses' home, dormitory, and a service building. A steam heating system will be installed in same. About $1,000,000. C. S. Palmer, 191 Church St., Archt.

Conn., Winsted—The St. James Protestant Episcopal is having plans prepared for a 1 story, 50 x 130 ft. church on Walnut St. About $100,000. Lockwood, Green & Co., 60 Federal St., Boston, Archts.

N. Y., Buffalo—The city, 1403 Telephone Bldg., plans to build a Niagara hydro electric plant.

N. Y., Buffalo—The Elks Club., 211 Delaware Ave., plans to build an 8 story, 125 x 225 ft. club and hotel building. About $600,000. Architect not selected.

N. Y., New York—The Bd. Educ., 500 Park Ave., will soon award the contract for an addition including a steam heating system, to P. S. 55, 170th St. and Washington Ave. About $750,000. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., New York—The Bd. Educ., 500 Park Ave., New York City, will receive bids until March 11 for a school including a steam heating system on Nostrand Ave. near Willoughby Ave., Brooklyn. About $850,000. C. B. J. Snyder, Municipal Bldg., New York City, Archt. and Engr.

N. Y., New York—The Bd. Educ., 500 Park Ave., received bids for the installation of heating and ventilating equipment in Public School 62, on the westerly side of Leggett Ave., between Southern Blvd. and Fox St., Borough of Bronx, from the Federal Heating Co., 300 Madison Ave., $129,-541; Gillis & Geoghegan, 537 West Bway., $133,300; Austin Eng. Co., 127 West 42nd St., $152,375.

N. Y., New York—The Dept. of Pub. Welfare received bids for furnishing and constructing a coal conveyor in the power house at Sea View Hospital, Borough of Richmond, from P. T. Cox Contg. Co., 154 Nassau St., $27,840; G. Colon & Co., 81 East 125th St., $28,250; C. W. Hunt Eng. Co., 143 Liberty St., $30,730.

N. Y., Richmond Hill (Jamaica P. O.)—The Bd. Educ., 500 Park Ave., New York City, plans to build an addition to the high school here including a steam heating system. About $1,200,000. C. B. J. Snyder, Municipal Bldg., New York City, Archt. and Engr.

N. Y., Schenectady—M. Spiegal, 1570 Bway., New York City, will soon award the contract for a theatre. About $500,000. Reilly & Hall, 405 Lexington Ave., New York City, Archts. and Engrs. Noted Jan. 11.

N. Y., Utica—The Utica Gas & Electric Co., 222 Genesee St., is having plans prepared for a 66 x 125 x 206 ft. power plant. About $1,750,000. T. E. Murray Inc., 55 Duane St., New York City, Consult. Engr. B. White, 1019 Steuben St., Engr.

N. J., Lakehurst—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to construct a hydro generating building, including equipment.

N. J., Newark—The Chamber of Commerce, Market St., is having plans prepared for a 10 story, 80 x 100 ft. office building including a steam heating system on Branford St. and Treat Pl. About $250,000. Guilbert & Betelli, 2 Lombardy St., Archts. and Engrs.

Pa., Chambersburg—The Borough of Chambersburg, Borough Hall, plans to build a 1 story, 80 x 90 ft. power house. A. C. Woods, Stock Exch. Bldg., Engr.

Pa., Hamburg—The Bd. Educ. will soon receive bids for a 2 story, 85 x 150 ft. high school on 4th and State Sts. About $150,-000. Hersh & Schollar, Altoona, Archts.

Pa., Johnstown—The Bd. Educ. will soon receive bids for a 2 story school at Maple Park. About $175,000. J. E. Adams, Memo Bldg., Archt.

Pa., Johnstown—The U. S. Natl. Bank is having plans prepared for a 16 story, 60 x 110 ft. bank on Franklin St. About $1,000,000. Dennison & Hirons, 475 5th Ave., New York City, Archts.

Pa., Pittsburgh—The Y. M. C. A., Magee Bldg., has had plans prepared for a 15 story, 80 x 120 ft. Y. M. C. A. building on Wood St. between 3rd and 4th Aves. About $650,000. B. Janssen, Century Bldg., Archt.

Pa., Wellsboro—O. B. Roberts & Son, Bache Auditorium, will soon award the contract for a 1 story, 50 x 187 ft. theatre on Main St. About $150,000. H. Spann, 52 West Chippewa St., Buffalo, Archt.

Pa., Williamsport—The Williamsport Hotel Co., c/o W. L. Stoddart, Archt. and Engr., 9 East 40th St., New York City, will soon award the contract for a hotel. About $1,000,000.

Md., Baltimore—The Circle Theatre Co. plans to build a 1 story theatre including a steam heating system at Park Circle and Reisterstown Rd. About $650,000. E. G. Blanke, 532 North Calvert St., Archt.

Md., Baltimore—The Union Trust Co., Fayette and Charles Sts., will soon award the contract for a 2 story, 85 x 150 ft. addition to office building. About $100,000. J. Pennington, 330 North Charles St., Archt.

Md., Texas—J. B. Logan, Pennsylvania R.R. and State Rd., is in the market for a 75 hp. horizontal boiler, locomotive type, standard make.

Va., Danville—The Masonic Temple Association will soon award the contract for a 10 story, 66 x 126 ft. temple. About $600,000. F. F. Farris, Schmulback Bldg., Wheeling, W. Va., Archt.

W. Va., Charleston—The State plans to build a state capitol building. About $1,000,000.

Fla., Eustis—The Fountain Inn Hotel Co. plans to build a 3 story, 100 x 175 ft. hotel. About $375,000.

Fla., Fort Pierce—The City Council plans an election to vote on $80,000 bonds to improve and enlarge the municipal light and water systems.

Fla., New Port Richey—The Palm Products Co., D. L. Rush, Purch. Agt., is in the market for one 10 hp. steam boiler for 100 lb. pressure.

Fla., Orlando—H. L. Beaman, c/o San Juan Hotel, plans to build a 7 story addition to his hotel. About $350,000. Architect not selected.

Tenn., Johnson City—The Automobile Renewal Co. Inc., is in the market for a 20 hp., 220 volt, 60 cycle electric motor, 1,200 r.p.m., etc. B. A. Mattres, Pres. and Mgr.

Tenn., Knoxville—The John G. Duncan Co., 101 East Jackson St., is in the market for 50, 60, 75 and 100 hp. locomotive boilers, return tubular boilers of same size and larger, hoisting engines with and without boilers, double cylinder and double drum, single cylinder and single drum, for 6 hp. to 25 hp. (used).

Tenn., Martin—The city plans to expend $100,000 to improve and enlarge the light and power plant.

Ky., Henderson—The Kiwanis Club plans to build an office building. About $400,000. Architect not selected.

O., Akron—The Bd. Educ., Central High School, will receive bids until March 15 for a 3 story, 65 x 250 ft. gymnasium and a 70 x 140 ft. auditorium including a steam heating system on Brittain Rd. About $800,000. F. L. Clepper, 102 South Union St., Engr.

O., Akron—The Commodore Perry Hotel Co. will receive bids until March 25 for an 8 story hotel and theatre building on Market and Prospect Sts. About $3,000,000. F. J. Fuller, Electrical Agt.

O., Akron—Peck & Sternberg, 317 Water St., will soon award the contract for a church on South Union St. About $250,000.

O., Akron—The Y. M. C. A., South Main St., plans to build a 4 story Y. M. C. A. building on Bowery St. and Buchtel Ave. About $750,000.

O., Ashtabula—The city is having plans prepared for a 1 story, 50 x 50 ft. power plant. About $100,000. Stone & Webster, Leader News Bldg., Cleveland, Archts. and Engrs.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., will receive bids until March 7 for a 3 story, 220 x 333 ft. high school including a steam heating system on Hopkins Ave. and East 118th St. About $1,500,000; 3 story, 220 x 333 ft. high school including a steam heating system at Woodland Hills Park. About $1,500,000. W. R. McCormack, Archt.

O., Cleveland—The Cleveland Pub. Library plans to build a 4 story library including a steam heating system on West 3rd St. and Superior Ave. About $2,500,000. Walker & Weeks, 1900 Euclid Ave., Archts.

O., Cleveland—The Cleveland Ry. Co., c/o G. Radcliffe, Mgr., Leader-News Bldg., plans to build a 1 story power plant. About $500,000. V. B. Phillips, 660 Leader-News Bldg., Engr.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ. received bids for a 2 story, 172 x 218 ft school on Noble Rd., from the Hearn Constr. Co., 4501 Euclid Ave., $263,510; Drummond Miller Co., 4500 Euclid Ave., $272,780; C. C. Kinney Co., Baujor Bldg., $273,500. All of Cleveland.

O., Lakewood—The Bd. Educ. will receive bids until March 14 for a 3 story high schoo at 10 Clifton Blvd. About $500,000. C. W. Hopkinson, Rose Bldg., Cleveland, Archt.

O., Shaker Heights—The Bd. Educ. plans to build a school on Kinsman and Lee Rds. About $300,000. J. M. Main, Clk. Architect not selected.

O., Trotwood—The Bd. Educ. plans to build a 2 story addition to school and a 2 story addition to high school. About $250,000. Peters, Herman & Brown, 1129 Reibold Bldg., Dayton, Archts.

O., Youngstown—The Bd. Educ. received bids for a 2 story, 222 x 312 ft. high school including a steam heating system on Ohio Ave., from the Moore Lamb Co., 203 Stambaugh Bldg., $598,000; Parish Bros., 217 Wick Ave., $662,913.

Ind., Indianapolis—The Indianapolis Battilion Armory Assn. had plans prepared for a 2 story, 120 x 160 ft. armory on Ashland Ave. About $100,000.

Ind., Terre Haute—John Eberson & Co., Archts. and Engrs., Steinway Hall Bldg., Chicago, Ill., will receive bids until March 4 for a 3 story, 140 x 185 ft. theatre and office building including a heating system, on 7th and Ohio Aves., for the Indiana Theatre Co., Trust Bldg. About $550,000.

Mich., Detroit—The Belle Isle Coliseum Co., East Jefferson Ave., plans to build a 1 story amusement building to replace the one destroyed by fire. Steam heating equipment will be installed in same. About $500,000.

Mich., Detroit—The Wheel Truing Brake Shoe Co., 219 Tuxedo Ave., will soon award the contract for a 2 story, 50 x 90 ft. factory including steam heating equipment. About $50,000. Kasurin Bros., 512 Empire Bldg., Archts.

Ia., Burlington—The Orpheum Theatre Circuit, M. Beck, Mgr., 190 North State St., Chicago, is having plans prepared for a 3 story theatre including a steam heating system. About $300,000. Kirchoff & Ross, Majestic Bldg., Milwaukee, Wis., Archts.

Ia., Corning—The city plans to build an electric light plant. About $60,000.

Ia., Mason City—The Mason City Hotel Co. will receive bids until March 3 for an 8 story, 142 x 167 ft. hotel including a steam heating system at 304 Federal St., N. C. H. McNider, Pres. Proudfoot Bird & Rawson, 810 Hubbell Bldg., Des Moines, Archts.

Ia., Reinbeck—The Bd. Educ. will receive bids until March 8 for a 2 story, 100 x 144 ft. high school including a steam heating system. About $225,000. Netcott & Netcott, 517 Black Bldg., Waterloo, Archts. Noted Dec. 7.

Minn., Minneapolis—The Asbury Hospital Assn. is having plans prepared for a 3 story addition to its hospital including a steam heating system at 914 Elliot Ave. About $250,000. Bertrand & Chamberlin, 616 Northwestern Bank Bldg., Archts.

Minn., Minneapolis—The Bd. Educ., City Hall, will soon award the contract for a 4 story, 200 x 300 ft. high school with a 1 story, 60 x 200 ft. wing, including a steam heating system on Monroe St. and 20th Ave., N. About $800,000. E. H. Enger, 305 City Hall, Archt.

Minn., North Branch—The city received bids for a waterworks system including a deep well, pump and tower tank from the Hedberg Boice Co., 2208½ West 2nd St., Duluth, $33,174; Huebscher & Ryan, 1323 Edmonton St., St. Paul, $37,000. Noted Jan. 4.

Minn., Princeton—Mille Lace County plans to build a 3 story court house including a steam heating system. About $200,000.

Neb., Norfolk—The Graham Ice Cream Co. is having plans prepared for a 2 story refrigeration plant. About $85,000. R. Everett, Omaha, Archt.

Mo., Moberly—W. H. Wilson, city clerk, will receive bids until March 10 for a 1 story, 46 x 110 ft. power house and is in the market for two 200-hp. horizontal water tube boilers with shaking and dumping grates and breeching, one 400 gal. per minute, 170 ft. head, centrifugal pump with 2,200 volt slip ring motor; one 700 gal. per minute, 175 ft. head, centrifugal pump with 2,200 volt slip ring motor; one 700 gal. per minute, 120 ft. head, centrifugal pump with 2,200 volt slip ring motor; one 2,250 gal per minute, 40 ft. head, centrifugal pump; one 700 gal. per minute, compound duplex 60 ft. head steam pump, alternate on 1 steam turbine driven centrifugal pump, 700 gal. per minute, 60 ft. head; one 400 hp. open feed water heater. Fuller & Beard, Chemical Bldg., St. Louis, Engrs. About $300,000.

Ark., Little Rock—The Peoples Ice Co., 712½ West 9th St., will soon receive bids for a 1 story, 150 x 200 ft. ice plant on 9th and Thayer Sts. About $100,000. Moody, Knight & Lewis, 512 A. O. U. W. Bldg., Archts. and Engrs.

Tex., Dallas—The Missouri, Kansas & Texas Ry. of Texas, Commerce and Market Sts., is having plans prepared for a 3 story freight building including a steam heating system on Houston and Ross Sts. About $300,000. E. L. Martin, 310 North Montclair St, Engr.

N. M., Albuquerque—The Albuquerque Hotel Stock Co. will soon receive bids for a hotel. About $250,000. Trost & Trost, Two Republics Bldg., El Paso, Tex., Archts.

Cal., Beaumont—The Directors of the Irrigation Dist. will receive bids until March 8 for the construction of pump houses, etc. Four deep well turbine pumps and six 20 hp. motors will be installed in same. H. B. Lynch, 1007 Van Nuys Bldg., Los Angeles, Engr.

Cal., Brea—The town received bids for furnishing a 4 in. pump and motor for the water system, from Byron Jackson Iron Wks., 336 East 3rd St., Los Angeles, $1,722 and $2,177, respectively; Fairbanks Morris Co., 427 East 3rd St., Los Angeles, $1,238 and $1,674; T. Haverty Co., 8th and Maple Ave., Los Angeles, $1,331 and $1,645.

Col., La Junta—The School Bd. will soon award the contract for a 2 story, 175 x 250 ft. high school. About $200,000. Montjoy French & Trewen, Chamber of Commerce Bldg., Denver, Archts.

Cal., Los Angeles—The St. Paul Pro Cathedral, 523 South Olive St., is having plans prepared for a 62 x 150 ft church on Olive St., near 6th St. About $300,000.

Cal., Los Angeles—The University Hospital Corp. is having plans prepared for three hospital buildings including a steam heating system on East Washington St. About $1,000,000. Curtis Tobey, 822 Security Bldg., Archt.

Ont., Ottawa — Darling & Pearson, Archts., 2 Leader Lane, Toronto, will receive bids about April 1 for a 3 story, 66 x 120 ft. bank on Sparks St., here, for the Canadian Bank of Commerce. About $500,000.

Ont., Sarnia—The Bd. Educ. will soon award the contract for a 3 story collegiate institute including heating and ventilation system. About $400,000. M. F. Thomas, 229 College St., Toronto, Engr. S. B. Coon & Son, 4 St. Thomas St., Toronto, Archt.

Ont., Sarnia—W. A. Brown & Sons, 218 Front St., plan to build a 1 story ice house to replace one destroyed by fire. Three electrical ice generators, 3 electric motors, 1 centrifugal pump and 1 electric crane will be installed in same. About $50,000.

Ont., Toronto—The Bd. Educ., 155 College St., plans to build a 1 story addition to Oakwood school, $180,000; Riverdale School, $120,000; Malvern School, $120,000. Extensions to the present heating system will be installed in same.

Ont., Toronto — The Bd. Educ., 155 College St., is having plans prepared for a 2 story collegiate institute including a vacuum steam heating system on Dufferin and Waterloo Sts. About $240 000.

Mex., Colima — The Cia Hidroelectrica Occidental S. A. plans to build a new 5,000 kw. hydro-electric plant on the banks of the Tuxpan River.

CONTRACTS AWARDED

Mass., Boston—The city has awarded the contract for a 3 story high school including a steam heating system on Louis Pasteur Ave., to G. A. Fuller Co., 131 State St., at $774,800.

Mass., Three Rivers—The Palmer Mills has awarded the contract for a 1 story, 30 x 70 ft. transformer building at its plant, to the McNally Bldg. Co. Inc., 41 Concord St., Framingham. Noted Feb. 1.

Mass., Woburn—The city has awarded the contract for the installation of a complete 270 hp. turbine pump to have a daily capacity of 50,000,000 gal. against a 230 ft. head, also a condenser, feed pump and piping, to Starkweather and Broadhurst, 53 State St, Boston.

N. Y., Elmhurst (Flushing P. O.)—The Jackson Heights Apartment Corp., c/o G. H. Wells, Archt. and Engr., 21 East 40th St., New York City, will build eight 4 story, 65 x 120 ft. apartments including a steam heating system on 29th St. near Fellmore Ave. About $600,000. Work will be done by day labor.

N. Y., New York—The Bd. Educ., 500 Park Ave., has awarded the contract for a school on Stebbins Ave. near East 163rd St., to Fraymeyer & Hanna at $792,100.

N. Y., New York—The Bd. Educ., Municipal Bldg., has awarded the contract for installing a heating and ventilating system in P. S. 38, Bronx, to Daniel J. Rice, 405 Lexington Ave., at $135,877.

N. Y., New York—The Dept. of Pub. Welfare, Municipal Bldg., has awarded the contract for the installation of a coal conveyor in the power house of the Seaview Hospital, to P. T. Cox Contg. Co., 154 Nassau St., at $27,840.

Pa., Conemaugh—The Bd. Educ. has awarded the contract for a 2 story, 79 x 131 ft. high school addition on First and Oak Sts., to the Wilson Constr. Co., Otto Bldg., Johnstown. About $125,000.

Pa., Philadelphia—The Franklin Trust Co., 18 South 15th St., has awarded the contract for an 11 story, 20 x 94 ft. bank addition and power plant, to John N. Gill Co., Otis Bldg.

Ala., Cordova—The U. S. Government Dept. of Inland Waterways has awarded the contract for furnishing belting and conveyors for coal loading bins here, to the Manhattan Rubber Mfg. Co., 2017 4th Ave., North, at $21,000.

O., Cleveland—The city has awarded the contract for furnishing a 500 kw., turbo generator unit, to MacGovern & Co. Inc., Chicago, Ill., at $5,000.

Ind., Indianapolis—H. L. Dollman, 1606 Merchants Bank Bldg., will build a 3 story, 106 x 297 ft. apartment house on Meridian St. About $225,000. Work will be done by day labor.

Ill., Chicago—Chin F. Foin, 426 South Wabash Ave., has awarded the contract for remodelling a 2 story, 75 x 125 ft. restaurant at 931 Wilson Ave., to the Krahl Constr. Co., 350 North Clark St., at $200,000. Present heating plant will be altered.

Kan., Wichita—The Mt. Carmel Academy has awarded the contract for a 4 story, 38 x 128 ft. dormitory, to Martin Carroll, Kansas City, Mo., at $125,000.

Tex., Dallas—The Y. W. C. A., 1515 Commerce St., has awarded the contract for a 3 story Y. W. C. A. boarding house including a vapor heating system on Haskell Ave., to the Watson Co., 1927 South Akard St., at $170,000.

"Opportunity" Advertising:

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Pages 77 to 88

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in.		63c. per ft.
Common, 2½-in.		5-10%

	Air		
	First Grade	Second Grade	Third Grade
½-in. per ft.	$0.40	$0.25	$0.19

Steam—Discounts from List

First grade..... 40% Second grade.....10-10-5% Third grade....60%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:
Competition..... 60-10-5% Best grade..... 40-10%
Standard..... 50-5%

LEATHER BELTING—Present discounts from list in fair quantities (1 doz. rolls):

Light Grade	Medium Grade	Heavy Grade
30-10%	30%	25%

RAWHIDE LACING { For cut, best grade, 35%, 2nd grade, 40%.
For laces in sides, best, 63c per sq. ft.; 2nd, 62c.
Semi-tanned: cut, 25%; sides, 65c per sq. ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	2.00
Duck and rubber for piston packing	1.60
Flax, regular	1.20
Flax, waterproofed	1.70
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.50
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.50
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.50
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are part of standard lists, with discounts.

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.70	3 -in.	.90
10-in.	1.30	3½-in.	1.05
85% magnesia high pressure			List +5%
For low-pressure heating and return lines		4-ply	50% off
		3-ply	52% off
		2-ply	54% off

PORTLAND CEMENT—New York, $3.10 without bags, in cargo lots delivered on job.

STRUCTURAL STEEL—New York warehouse price, 3 to 15-in. beams and channels and 3 to 6-in. angles and tees; all $3.58 per 100 lb.; plates, $3.78.

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
White	7.50@13.00	13.00	13.00	14.25
Colored mixed	7.00@11.00	9.00 to 12.00	11.00	12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13¼ x 20½
Cleveland	$55.00	$65.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$0.73	$1.80	$0.80	$1.98
5-gal. cans	.76	2.00	1.05	2.23

With lower prices obtainable in New York.

WHITE AND RED LEAD—Base price per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil	In Oil	Dry and In Oil	In Oil
100-lb. keg	13.00	14.50	15.00	16.50	13.00		15.00	
25- and 50-lb. kegs	13.25	14.75	15.25	16.75	13.25		15.25	
12½-lb. keg	13.50	15.00	15.50	17.00	13.50		15.50	
1-lb. cans	16.00	17.50	17.50	18.50	16.00		17.00	
5-lb. cans	18.00	19.50	19.50	19.50	18.00		18.00	

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ½ and smaller	45%	50%	45%
Tinned	45%	50%	30%

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:
New York.....$5.20 Chicago.....$5.08 Pittsburgh.....$3.90

Boiler rivets, same sizes:
New York.....$5.30 Chicago.....$5.18 Pittsburgh.....$4.00

REFRACTORIES—Prices in carlots:

Bauxite brick, 56% alumina, f.o.b. Pittsburgh	per 1000	$160
Chrome brick, eastern Shipping points	net ton	80
Chrome cement, 40@45% Cr2O3	net ton	45@ 50
Chrome cement, 40@45% Cr2O3, in sacks	net ton	55
Clay brick, 1st quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	55@ 60
Clay brick, 2d quality, fire clay, 9-in. shapes, Pennsylvania, Ohio and Kentucky	per 1000	45@ 50
Magnesite brick: 9-in. straight	net ton	100
Magnesite brick: 9-in. arches, wedges and keys	net ton	105
Magnesite brick: Soaps and splits	net ton	120
Silica brick: Chicago district	per 1000	55@ 60
Silica brick: Birmingham, Ala	per 1000	45@ 51
Silica brick: Mt. Union, Pa	per 1000	45@ 50

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	70.00	70.00	46.00	70.00	35.00	70.00
Commercial	30.00	30.00	16.50	20.00	9.00	15.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5.50	$5.25	$4.84
Flats, square and hexagons, per 100 lb. base	6.00	5.75	5.34

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	50%
Boiler lugs	Net list
Boiler stay bolts	60%
Boiler patch bolts	+10%
Boiler fitting-up bolts	25%
Pressed steel boiler lugs	Net list
Pressed steel boiler hangers	Net list

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
⅛ to 3	57½	44	⅛ to 1¼	24½ to 25½	8½ to 09½

LAP WELD

2	50½	38	2	20½ to 21	6½ to 07
2½ to 6	53½	41	2½ to 6	22½ to 23	9½ to 10
7 to 12	50½	37	7 to 12	19½ to 20	6½ to 07
13 and 14	41				
15	38½				

BUTT WELD, EXTRA STRONG, PLAIN ENDS

⅛ to 1¼	55½	43	⅛ to 1¼	24½ to 25½	9½ to 10½
2 to 3	56½	44			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	48½	37	2	21½ to 22½	8½ to 09
2½ to 4	51½	40	2½ to 4	23½ to 24	11½ to 12
4½ to 6	50½	39	4½ to 6	22½ to 23	10½ to 11
7 to 8	46½	33	7 to 8	14½ to 15	2½ to 03
9 to 12	41½	28	9 to 12	9½ to 10	5½ to+2

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.27
1¼	.....	.....	.26
1½	.....	.....	.24
1¾	$0.2200	$0.3255	.26
2	.2100	.2834	.25
2¼	.2400	.3176	.29
2½	.2910	.3814	.36
2¾	.3298	.4323	.39
3	.3686	.4781	.43
3¼	.4365	.5663	.51
3½	.4032	.5728	.55
4	.5124	.70	.72

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2¾ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3¼ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 65.00 (net)	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	10%	List
Coils to 1,000 ft	15%	10%
1,000 ft. and over	20%	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever-Ready:

	Each, Net
Less than 12	$0.48
12 to 50	.41
50 to 125 (bbl.)	.38
125 (bbl.) or over	.35

CONDUIT, Price per 1000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

	Conduit		Elbows		Couplings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.
¼	74.30	79.40	17.75	18.90	6.55	6.95
⅜	98.20	105.10	23.35	24.85	9.35	9.95
½	145.20	155.40	34.55	36.80	12.15	12.90
¾	196.40	210.20	44.25	46.95	16.75	17.75
1	234.85	251.35	59.00	62.65	20.65	21.90
1¼	316.00	338.20	108.25	114.85	27.55	29.20
1½	499.60	534.70	177.10	187.90	39.35	41.75
2	653.30	699.20	472.30	501.10	59.05	62.65
2½	813.30	886.50	1,043.05	1,106.65	78.70	83.50
3	995.35	1,050.75	1,205.40	1,278.90	98.40	104.40

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
¾	250	$0.05½
⅞	250	.06
1	250	.09
1¼	200	.12
1½	200	.15
1¾	150	.18
2	100	.25
2½	100	.33
3	Odd lengths	.40
4	Odd lengths	.55

1000 ft. and over..... 55%
Coils..... 45%
Less coils, 35%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.43
D. P. M. L.	.21	T. P. to D. P. S. B.	.26
T. P. M. L.	.33	T. P. S. B.	.38
D. P. S. B.	.23	T. P. D. B.	.64

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.50	$1.30	$1.68
T. P. M. L.	.70	1.70	2.40
D. P. S. B.	.63	1.60	.....
T. P. S. B.	1.15	2.40	.....
D. P. D. B.	1.10	3.00	.....
T. P. D. B.	1.90	5.40	.....
T. P. to D. P. D. B.	1.30	3.80	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$17.72
No. 16 cotton twisted	21.89
No. 18 cotton parallel	22.00
No. 16 cotton parallel	25.40
No. 18 cotton reinforced heavy	31.62
No. 16 cotton reinforced heavy	35.45
No. 18 cotton reinforced light	29.30
No. 16 cotton reinforced light	32.00
No. 18 cotton Canvasite cord	22.97
No. 16 cotton Canvasite cord	27.06

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.25	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	.035	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
425-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 15%; 1-5th to standard package, 28%; standard package, 45%.

RENEWABLE FUSES, ENCLOSED—

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50 ea.	$1.10 ea.	100	10
35 to 60-amp.	1.00 ea.	1.25 ea.	100	10
65 to 100-amp.	2.00 ea.	3.00 ea.	50	5
110 to 200-amp.	4.00 ea.	5.00 ea.	25	5
225 to 400-amp.	7.50 ea.	11.00 ea.	25	1
450 to 600-amp.	11.00 ea.	16.00 ea.	10	1
450 to 600-amp.	11.00 ea.	16.00 ea.	10	1

RENEWAL LINE FOR ABOVE FUSES—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea	15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	Net list
Unbroken carton but less than std. pkg	10%
Std. pkg.	18%
Discount Without Contract—Renewals:	
Less than std. pkg	Net list
Standard package	18%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons but less than standard package	15%
Standard package	23%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	23%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$5.250
0–30 ampere, less than standard package	6.000

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs — Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.40	$0.45	100	75	$0.75	$0.80	50
15	.40	.45	100	100	1.10	1.25	24
25	.40	.45	100	150	1.55	1.70	24
40	.40	.45	100	200	2.10	2.30	24
50	.40	.45	100	300	3.15	3.40	24
60	.45	.50	100				12
				500	4.60	4.90	12
				750	6.50	6.90	8
				1,000	7.50	7.95	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.28
Composition 2-piece attachment plug	.36
Swivel attachment plug	.20
Current taps	.45

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 8.25	$11.50	$15.08	$23.00
12	12.00	15.94	18.47	30.56
10	10.59	19.49	23.42	39.19
8	22.82	26.77	30.91	52.60
6	.....	.....	42.70	.....
4	.....	.....	59.00	.....
2	.....	.....	85.13	.....
1	.....	.....	107.95	.....
0	.....	.....	127.62	.....
00	.....	.....	150.14	.....
000	.....	.....	182.57	.....
0000	.....	.....	224.67	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	¾ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	+50%
1-5th to standard package	+20%
Standard package	—15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B. & S. regular spools (approx. 8 lb.)	47c. lb.
No. 18 B. & S. regular 1-lb. coils	48c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 56c. lb., 100 lb. lots	52c. lb.
Rubber tape, ¾ in., less 100 lb. 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 47c. lb., 100 lb. lots	42c. lb.
Soldering paste, 2 oz. cans	$1.50 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	—10%
$200 list value or over	—15%